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GEOLOGICAL SURVEY



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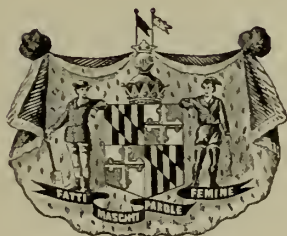
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MARYLAND GEOLOGICAL SURVEY

ALLEGANY COUNTY

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ALLEGANY COUNTY

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Also with the cooperation of several members of the scientific
bureaus of the National Government.

LETTER OF TRANSMITTAL

To His Excellency JOHN WALTER SMITH,

Governor of Maryland and President of the Geological Survey Commission.

Sir:—I have the honor to present herewith a report on The Physical Features of Allegany County. The Volume constitutes the first of a series of reports on county resources, and is accompanied by an Atlas with large scale topographical and geological maps. The information brought forward in these publications is of both economic and educational significance and I believe will prove of interest and value both to those who are residents of the county and those from a distance who may be considering sites for homes or for the investment of capital therein. I am,

Very respectfully,

WM. BULLOCK CLARK,

State Geologist.

JOHNS HOPKINS UNIVERSITY,

BALTIMORE, November, 1900.

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PREFACE

The present volume on Allegany County inaugurates a new series of reports dealing with the physical features of the several counties of Maryland. Not only the geology and mineral resources of Allegany County will be considered but also the physiography, soils, climate, hydrography, magnetic declination, forests and life characteristics. The geological chapters are limited to a descriptive discussion of the stratigraphy and structure, the systematic treatment of the geology and the paleontology awaiting later consideration.

The *Introduction* contains a brief statement regarding the location and boundaries of Allegany County and its chief physical characteristics.

The Physiography of Allegany County, by Cleveland Abbe, Jr., embraces a discussion of the surface characteristics of the region, including not only a description of the outward forms but presenting reasons for their existence and resisting the processes by which they have been produced. Dr. Abbe's general report on the physiography of the whole state in Vol. I of the Maryland Weather Service is here supplemented by a detailed discussion of the physiography of Allegany County.

The Geology of Allegany County, by Cleophas C. O'Harra, deals with the stratigraphy and structure of the county. An historical sketch is given of the previous work done in this field, to which is appended a complete bibliography. The chapter dealing with the interpretation of the sedimentary record deserves especial mention since it gives an interesting history of this portion of Western Maryland.

The Mineral Resources of Allegany County, by Wm. B. Clark, C. C. O'Harra, R. B. Rowe and H. Ries, deals with the economic wealth of Allegany County, contained in its rocks—the coal, brick, cement and other industries are described.

The Soils of Allegany County, by C. W. Dorsey, contains a discussion of the leading soil types of the county and their relation to the several geological formations. It is an important article, showing the close relations between the soils and geological formations. This investigation was conducted under the direct supervision of Prof. Milton Whitney, Director of the U. S. Soil Survey of the Department of Agriculture, who detailed Mr. Dorsey to carry on the actual work in cooperation with the Maryland Geological Survey.

The Climate of Allegany County, by O. L. Fassig, is a valuable digest of the leading climatic features of the county. Dr. Fassig is a Section Director in charge of the Baltimore Office of the U. S. Weather Bureau and has a thorough knowledge of Maryland Climate.

The Hydrography of Allegany County, by F. H. Newell, gives an excellent account of the available water power in the upper Potomac basin. Mr. Newell is the Chief of the Division of Hydrography of the U. S. Geological Survey and his paper is an important contribution to the hydrography of Allegany County.

The Magnetic Declination in Allegany County, by L. A. Bauer, contains much important information for the local surveyors of the county. Dr. Bauer is the Chief of the Division of Terrestrial Magnetism of the U. S. Coast and Geodetic Survey and has been engaged for several years past in making a magnetic survey of Maryland under the auspices of the State Geological Survey.

The Forests of Allegany County, by G. B. Sudworth, is a contribution of much significance to the forestry interests of Maryland. Mr. Sudworth has studied the forestry conditions of the county with much care and has brought together many important facts regarding the present and future prospects of the lumber industry. Mr. Sudworth is Dendrologist of the Forestry Division of the U. S. Department of Agriculture.

The Fauna and Flora of Allegany County, by C. Hart Merriam and Edward A. Preble, contains a discussion of the life zones of the county, together with a list of the summer birds of Western Maryland. Dr. Merriam is the Chief of the Biological Survey of the U. S. Department of Agriculture and Mr. Preble one of his associates. They

have been engaged in cooperation with the Maryland Geological Survey in a study of the life characteristics of the Appalachian region.

The State Geological Survey desires to extend its thanks to the several National organizations which have liberally aided it in the preparation of many of the papers contained in this volume. The Director of the U. S. Geological Survey, the Superintendent of the U. S. Coast and Geodetic Survey, the Chief of the U. S. Weather Bureau, the Chief of the Biological Survey and the Chiefs of the Soil and Forestry Divisions of the Department of Agriculture have granted every facility in the conduct of the several investigations. The value of the report has been much enhanced thereby.

The illustrations contained in the volume have been obtained from various sources. Many of the photographs were taken by the authors of the several papers while in the field. The Baltimore and Ohio Railroad and the Consolidation Coal Company have also generously loaned some of the most effective illustrations used. The view from Wills Mountain is the work of the Wertz's Art Studio of Cumberland, while the views from Dans Mountain were taken by Mr. L. E. Jewell, of the Johns Hopkins University.

THE
PHYSICAL FEATURES
OF
ALLEGANY COUNTY



CUMBERLAND AND THE NARROWS OF WILLS MOUNTAIN, FROM SHIVER RIDGE.

THE PHYSICAL FEATURES OF ALLEGANY COUNTY

INTRODUCTION.

Allegany county occupies a central position among the three mountainous counties of Western Maryland. It is located between the parallels $39^{\circ} 26'$ and $39^{\circ} 44'$ north latitude and the meridians $78^{\circ} 20'$ and $79^{\circ} 4'$ west longitude and covers an area of 477 square miles. The county is bounded on the north by Mason and Dixon's line, which runs between it and Somerset, Bedford and Fulton counties, Pennsylvania; on the east by Sideling Hill Creek, which separates it from Washington county, Maryland; on the southeast and south by the Potomac river, separating it from Morgan, Hampshire and Mineral counties, West Virginia; and on the west by Garrett county, Maryland, the boundary being a straight line drawn from the top of Savage Mountain where it is crossed by the Mason and Dixon's line to the middle of the mouth of Savage river.

Allegany county, as an independent division of the state, dates from 1789, when an act was passed by the General Assembly creating out of the then existing confines of Washington county a new county which should include all that portion of the state lying to the west of Sideling Hill Creek. This continued to be the limits of Allegany county until 1872, when the General Assembly of that year created out of the western part of the county the new county of Garrett, which was to include all that portion of Allegany county lying to the north and west of "a line beginning at the summit of Big Backbone, or Savage Mountain, where that mountain is crossed by Mason and Dixon's line and running thence by a straight line to the middle of Savage river where it empties into the Potomac river." Several

attempts were made to establish this line, but they were unsuccessful until 1898, when the Maryland Geological Survey was requested by Governor Lowndes, in accordance with an act of the General Assembly of that year, to accurately locate the boundary. The line was an extremely difficult one to run since the points were not intervisible, and the country rough and mountainous. The work was successfully accomplished at the close of the summer of 1898 and the line marked with suitable monuments.

The largest place in the county is Cumberland, built on the site of old Fort Cumberland of colonial days, a progressive city of 20,000 inhabitants. It is the county-town and the center of the commercial life of the upper Potomac valley. Other prosperous towns are Frostburg, Lonaconing and Westernport.

There are few regions more salubrious in climate or more beautiful in scenic surroundings than Allegany county. It is crossed from north to south by a succession of tree-clad mountains, while the intervening valleys are dotted with prosperous farms. Along its full length from west to east the Potomac river meanders through a beautiful valley, in part bordered by a broad, alluvial floodplain that affords rich farming lands, but more often confined by a deep, narrow gorge that presents the wildest of mountain scenery. Few regions anywhere are better provided with natural advantages for comfortable residence.

The economic resources of Allegany county are very extensive, the annual output aggregating several million dollars in value. Among the developed and undeveloped products are coal, fire-clay, cement-rock, iron ore, building-stone, road-metal, brick-shales, alluvial clays and mineral waters. To these should be added a great variety of soils, capable of producing diversified crops.

Allegany county has from an early period possessed unusual facilities for the transportation of its products. The construction of the Cumberland Turnpike Road by private enterprise early in the century, and its extension westward to the Ohio by the general government as a National Road, brought Allegany county at an early day into direct communication with the regions both to the east and the

west of the Alleghenies. With the improvement in methods of transportation Allegany county early benefited, as the era of internal improvement brought toward the middle of the century the Baltimore and Ohio Railroad and the Chesapeake and Ohio Canal within its confines. Its valuable coal had already to some extent reached distant markets by means of rafts floated down the Potomac river, but with the advent of the railroad and canal the shipment of coal, iron, fire-brick and the products of the soil was rendered possible on a large scale, and Allegany county advanced from that time forward with rapid strides until it has come to reach its present position of commercial prosperity. Other railroads were gradually added, the Pennsylvania Railroad system tapping the region from the north while the West Virginia Central and Pittsburg Railway entered the county from the south. Two local railroads, the Cumberland and Pennsylvania and the Georges Creek and Cumberland, constructed mainly for the purpose of removing the great output of coal from the Georges Creek basin, supply the necessary transportation facilities to the most prosperous districts of the county.

The succeeding chapters are devoted to a consideration of the physiography, the geology, the soils, the hydrography, the climate, the terrestrial magnetism, the forestry, and the fauna and flora of the county.

W. B. C.

THE PHYSIOGRAPHY OF ALLEGANY COUNTY

BY

CLEVELAND ABBE, JR.

INTRODUCTORY.

There are, in general, two methods of studying the topography of any area. The first and older method describes the outward forms of the surface features and classifies them according to their outward resemblances and dissimilarities only. The second and later method seeks, from a study of the outward forms, to discover the reasons for their existence and the processes by which they have been produced. When these latter are understood, it then becomes possible to classify surface forms according to the origin or genesis of each, *i. e.* to classify them on a genetic basis. The present physiographic study of Allegany county aims to so present its topography and topographic development as to make clear the reasons why the county has the surface features which characterize it. These features, when rightly interpreted, reveal successive stages in the geologic and topographic history of the county.

In Maryland the boundaries of the Appalachian Province include the three westernmost counties of the state, viz., Garrett, Allegany and Washington, and also the western portion of Frederick county.¹ This topographic province has been divided into three sub-provinces; namely, the Alleghany Plateau, the Greater Appalachian Valley and the Blue Ridge or Catoclin district. The major portion of Allegany county lies in the western part of the Greater Appalachian Valley,

¹ Maryland Geological Survey Reports, vol. iii, pl. iii, Map showing the Physiographic Provinces of Maryland.

and includes about one-half of that portion of the sub-province which, because of its peculiar topography, is called the district of the Alleghany Ridges. The western part of the county takes in a narrow strip along the eastern edge of the Alleghany Plateau.

PHYSIOGRAPHIC DIVISIONS.

As Allegany county lies in two of the subdivisions of the Appalachian Province, it may be divided into two corresponding, well-marked topographic districts. One of these districts includes all that portion of the county which lies to the west of the eastern foot of Dans and Piney mountains, and will be called *the Plateau District*, as it is a portion of the Alleghany Plateau sub-province. The other district includes that portion of the county lying between Piney Mountain and Sideling Creek. As this portion of the county lies within the sub-province of the Alleghany Ridges, it will be called *the Ridge District*.

THE PLATEAU DISTRICT.

The Topography of the Plateau District.—The topography of the Plateau District is simple when compared with that of some other portions of Maryland, such as the Piedmont Province. It consists of an elevated area lying between two long parallel mountain crests, and may be most conveniently divided into the general upland, the bounding mountains, and the outer slopes of the latter.

The general upland, lying between the parallel northeast-southwest ridges of Dans and Big Savage mountains, has a strongly rolling surface. This is due to the steep-sided stream valleys, which often cut deeply into what would be, otherwise, an even surface lying about 2100 feet above mean sea-level. The undulations of the surface are most strongly marked along a line about midway between the bounding crests. They gradually fade out on either side this line, melting into the gentler, even slopes which lead up from it to the boundaries. This rolling surface is most continuously and typically developed over that portion of the district lying between Frostburg and the Pennsylvania line. Frostburg, itself, occupies one of the broader interstream areas. Going southwestward from Frostburg,



VIEW OF MODEL OF ALLEGANY COUNTY.

which is at an altitude of about 2000 feet, the general surface rises gradually. The average elevation of the upland thus increases from about 1900 feet at the Pennsylvania line, to nearly 2500 feet near the southwestern corner of the county. This increase in elevation southwestward is accompanied by an increase in the number and depth of the stream valleys. The general upland thus becomes more and more cut up and dissected. This is best shown by the reproduction of the model of the county, Plate II, and the topographic map of the county contained in the Physical Atlas.

The altitudes attained by a number of hills belonging to the present general upland are given in the accompanying Table of Elevations. They show the gradual rise of the surface southward, which is downward in the table, and when studied with a view to variations above or below a mean plane do not reveal a very great range. This latter fact suggests the idea that formerly the surface of the plateau was less rolling and lay an almost even surface, several hundred feet above present stream channels.

TABLE OF ELEVATIONS OF THE PLATEAU DISTRICT, ALLEGANY CO.

Crest of Big Savage Mt.	General Upland.	Crest of Dans-Little Allegheny.
2780 feet.	.....	2155 feet.
2889 "	1900 feet.	.....
.....	.....	2262 "
2942 "	1977 "	.....
2920 "	2106 "	2407 "
2930 "	2021 "	2410 "
3022 "	2241 "	2621 "
2900 "	2200 "	2882 "
3400 "	2120 "	2769 "
2859 "	2400 "	2760 "

The slopes of the upland pass rather gradually into the slopes leading to the boundaries of the district. These boundaries are the long, straight, even crests of Big Savage Mountain on the west and Dans Mountain on the east. They owe their prominence to upturnings of the resistant Pottsville sandstone which now forms the crests of both mountains. Because of this sudden upward bending of the strata around the edges of the plateau, the outer slopes of the bound-

ing mountains are much steeper than the inner slopes which lead back towards the elevated general upland. The boundaries of the plateau therefore have unsymmetrical slopes, the steeper and shorter falling, often precipitously, to the valleys of the Savage and the Potomac rivers, the longer, gentler slopes melting back into the upland.

One remarkable and characteristic feature of both boundaries is the almost unbroken continuity of their crests. Throughout its length in Maryland, Dans Mountain and its continuation, Little Allegheny, is but three times crossed by streams. On the south the Potomac cuts its way across in a gorge at Piedmont, W. Va., fifteen miles to the northeast, Braddock Run crosses the mountain in a narrow V-shaped gorge 1200 feet deep, and four miles farther on Jennings Run cuts a somewhat similar gorge across Little Allegheny. Big Savage Mountain is not crossed by streams equal in size to those just mentioned, and therefore has not been so deeply cut by gorges. The interstream stretches of Dans Mountain maintain a more nearly uniform, though lower altitude than does the less deeply but more minutely interrupted crest of Big Savage Mountain. The average crestline altitude of the latter mountain is 2913 feet, that of the former is 2517 feet above mean sea-level. The trend of the crests of both mountains is parallel to the general northeast-southwest trend of all this portion of the Appalachians.

The Drainage of the Plateau District.—The streams of the Plateau District are all comparatively small, with the single exception of the North Branch of the Potomac. Georges Creek, which is the largest of the streams, is about 15 miles in length. It drains the greater portion of the district, flowing midway between Dans and Big Savage mountains southwestward to join the North Branch of the Potomac at Westernport. The valley of Georges Creek is slightly tortuous in character and very deep in comparison with its width. As the stream is subject to spring and fall floods, considerable quantities of soil and debris have been washed into the channel from the steep slopes leading down from the hilltops of the upland. Consequently a narrow flood-plain of boulders, coarse gravel and sand has been

formed. The southward increase in depth of the valley is accounted for by increased steepness of the side slopes. The creek is fed by numerous small streams heading along Dans and Savage Mountains and occupying narrow, steep-sided ravines in which minor flood-plains are also developing as the result of the rapid waste of the less resistant strata.

The northern portion of the general upland is drained by Braddock and Jennings runs, two tributaries to Wills Creek. These two streams differ from Georges Creek in leaving the Plateau District through transverse gaps in the northern part of its eastern boundary, *i. e.* Piney and Little Allegheny mountains. They run against the inward or westward dipping strata of these mountains and are therefore in striking contrast to Georges Creek, which follows down the southward sloping axis of the stratigraphic trough which makes up the Plateau District. Their valleys are characteristically narrow and steep-sided. Jennings Run has developed a rather narrow but well-defined valley lowland between Mt. Savage and Little Allegheny. This is probably due to locally resistant layers near Mt. Savage. The sharp ravines and steeper grades which mark the headwaters of these streams indicate that they are, at present, more aggressive than the headwaters of Georges Creek; but it is not certain that they will long continue so. The steep and narrow gorge which now characterizes the lower course of Georges Creek indicates that that stream has been actively at work in recent times, eroding the yielding rocks of the Lower Coal measures (Allegheny formation). This activity has not yet affected its headwaters. In the deepening and widening of their valleys, the two northern streams are now opposed by the resistant Pocono and Pottsville strata. These have a much lower elevation at the mouth of Georges Creek than they have where Braddock Run and Jennings Run cross them. Therefore Georges Creek will be able to reduce its valley-floor to a lower level more quickly and easily than can Braddock and Jennings runs.

Besides noticing these three leading drainage lines, attention should be called to the large number of small streams, most of them intermittent in character, which drain the eastern slope or face of Dans

Mountain. They have brought out, by a sort of etching process, the several layers of which the mountain is made up. By removing the yielding strata underlying the resistant summit rock (Pottsville), the crest has come to present a precipitous rocky face on the eastern side. At somewhat regular intervals spurs run from the foot of this cliff and reach one-half way down the mountain to rounded knobs of Pocono sandstone, while in behind these eminences gullies and ravines are growing along the yielding Mauch Chunk and Greenbrier strata, reaching on either side from the main furrows leading down the slope to the North Branch of the Potomac. Still lower down, at about 1800 feet, are rounded foothills marking the junction of the Hampshire and Jennings formations.

The Structure of the Plateau District.—The structure of the Plateau District is comparatively simple. The rocks which enter into its composition are the youngest Paleozoic strata in the county. They are of many degrees of resistance, and range from the slowly yielding quartzitic Pocono sandstone to the yielding shales of the Hampshire and Dunkard formations. The structure sections accompanying the report on the geology of the county (Pl. XVI) show that these strata are but slightly disturbed. It appears that they have been bent into a broad shallow trough or syncline. The central depression of this trough now stands higher than the deep valleys of Savage and Potomac rivers on either side. The trough is much longer than it is wide, and extends from Somerset county, Pennsylvania, across Maryland and continues southwestward for a number of miles into West Virginia. The strata contained in this trough show very slight and unimportant minor disturbances, but the trough as a whole is tipped slightly southwestward, or its longer axis is observed to rise gently towards the northeast. This inclination of the longer axis is not sufficient to cause a convergence of the outcrops of the different strata. On the contrary, the long parallel crests of Big Savage, Little Savage and Dans mountains do not betray, within the boundaries of Maryland, the fact of this tipping. The strata which make up the Plateau District therefore appear on the eastern slope of Dans Mountain as long parallel bands of rock dipping some-

what steeply northwestward into the mountain. Within the limits of the upland area the strata lie for the most part almost horizontal, tipping up rather rapidly only in the immediate vicinity of the two bounding crestlines.

There are, then, within the Plateau District two distinct types of structure which will affect the topography and drainage-pattern of the district. Along the boundaries the structure is essentially monoclinal, while within the upland area the structure is horizontal in character.

Stream Adjustments in the Plateau District.—The streams of the district present several interesting examples of both adjustment and non-adjustment to the structural features just outlined. The only marked example of complete adjustment to the existing structure is furnished by Georges Creek. This stream, which occupies an axial position in that portion of the plateau which in former times would seem to have been the bottom of the great trough, probably belongs to the class of consequent streams which were described by Professor Davis in his study of the Pennsylvania drainage. These streams always occupy positions which they would be compelled to take if the configuration of the surface were determined only by the foldings and dislocations of the strata. The tributaries to Georges Creek in general confirm this classification of the main stream. They run into the creek almost at right angles to its general direction after having themselves followed courses down the gentle dip of the strata on either side of the structural trough. The headwaters of many of these side-streams show a tendency, sometimes very marked in its character, to develop along the more yielding bands which run parallel to the general trend of the boundaries in the vicinity of the crestlines. Among the better marked examples of this incipient adjustment to the structure as it is revealed by erosion, may be mentioned the headwaters of Winebrenner Run, Elk Lick Run and Wrights Run.

The most marked cases of discordant or unadjusted drainage are those of Braddock Run and Jennings Run. These two streams, as has already been mentioned, drain the northern portion of the district

by cutting their way eastward directly across the crests of Dans and Piney mountains. They are thus in striking contrast to Georges Creek and its tributaries. It is only in the tendency of their headwaters to seek out adjusted subsequent courses along the tilted strata on the western slopes of Dans Mountain that they bear any resemblance to Georges Creek. Beyond the boundaries of the district they become a part of the Wills Creek drainage system of the Ridge District, and here show more perfect adjustment to existing structures. Their discordant location upon the boundary of the Plateau District and the adjustments of their lower courses, seem to be very clearly connected with the development of certain topographic features of the Ridge District. The discussion of these streams will therefore be deferred until the drainage development of a portion of the Ridge District has been considered.

The remaining streams of the Plateau District, those small streams flowing down the east slope of Dans Mountain, show a slight degree of adjustment along their headwaters. Their upper courses are generally in narrow vales between the knobs of Pocono sandstone and the Pottsville which forms the crest. The major portion of their courses lies at right angles to the strike or outcrop of the strata and they run against the dip. They have developed chiefly as wet-weather streams on the valley slopes, gradually increasing in length as the Potomac has cut its valley deeper.

THE RIDGE DISTRICT.

The Topography of the Ridge District.—The topography of the Ridge District is much more varied than is that of the Plateau District. The most distinctive features of the topography are the sets of long, parallel, sharp-crested ridges and narrow intervening valleys which here cross the state from northeast to southwest. The general parallelism of the prominent topographic features is best shown by the model of the county (Plate II). The model of the State of Maryland¹ and the hypsometric map² also bring out these features.

The most prominent ridges of the district are Wills Mountain,

¹ Maryland Geol. Survey, Vol. i, 1897, plate i.

² Ibid., plate vi.

rising to a height of 1870 feet; Martin Mountain, above 1980 feet; Warrior Mountain, 2135 feet; Polish Mountain, 1740 feet; and Town Hill, 2000 feet. Minor ridges such as the Devil's Backbone west of Wills Mountain, Shriver Ridge at Cumberland and Fort Hill are sometimes found subdividing the valleys between the major elevations. In nearly all cases the ridges are the southward continuations of elevations which are perhaps more typically developed in Pennsylvania. Their distinctive features in that state are the long, even and uninterrupted crestline, the generally uniform and but slightly ravined slopes, and the marked mutual parallelism of direction. Such a description will apply equally well to the Maryland ridges. In Allegany county, however, a number of the ridges do not pass completely across the state, but decline in elevation quite rapidly just before reaching the Potomac. The resultant rather tapering points leading down to lower levels in the immediate vicinity of the Potomac are well illustrated in the southern terminations of Warrior Mountain and Polish Mountain. The minor ridges are also characterized by even crestlines and a general parallel arrangement which is in harmony with that of the larger ones. They are, however, much more frequently interrupted by the crossing and recrossing of streams, while their slopes are somewhat less frequently dissected by small streams.

The cross-profiles of the ridges are commonly very expressive of the internal structure or the attitude of the strata which make them. Some of the ridges are due to the arching up of a stratum of resistant sandstone or quartzite. Then either slope has its steepness controlled by the inclination of that resistant layer. If the arch is symmetrical, giving equal inclination on either side, that fact will appear in the symmetrical cross-profile of the ridge. Should one side have a steeper dip than the other, as is the case in Wills Mountain, then the slopes of the ridge are found to be unequal. Sometimes, as in Shriver Ridge, the ridge is due to a resistant stratum underlain and overlain by yielding layers, the whole being inclined in one direction. Then by the removal of the yielding strata, the resistant one has been brought into relief as a ridge whose one side is of gentle slope agree-

ing with the dip of the rocks, while the other side is steep where undermining has gone on by the removal of the yielding rocks lying below the ridge-making stratum. Such ridges may be called *monoclinical ridges*, since the strata which make them are all inclined in the one direction. Those ridges and mountains which, like Wills Mountain, are arches of rock, may be called *anticlinal ridges*. Wills Mountain and Evitts Mountain are the best examples of this type of ridge. Warrior Mountain is also anticlinal in structure, but its crest owes its prominence not to the resistance of a roof of sandstone, but to its Oriskany sandstone flanks, which have prevented streams from attacking the weak limestone core. There is one other type of ridge in this district, viz., the *synclinal ridge*. Such a ridge is characterized by a trough-like internal arrangement of its strata with a bed of resistant rock forming the crest or serving as a barrier along the sides and protecting the more yielding rocks beneath it. Town Hill, with its narrow capping of Pocono sandstone protecting the Hampshire shales beneath it, seems to be the only example of such a ridge in this district.

The area occupied by the higher and more important ridges is a comparatively small proportion of the Ridge District. By far the greater area is occupied by the valleys between these ridges. As these valleys have an average elevation above mean sea-level of about 900 feet, the mean elevation of the district is several hundred feet (800) below that of the Plateau District. These valleys are the result of erosion, which has removed the more yielding rocks, leaving the resistant strata as ridges. No case has been found where a present valley in the Ridge District coincides as closely with a structural trough or syncline as was found to be the case with the Georges Creek valley in the Plateau District. All the larger valleys seem to have been determined, both as to position and direction, by the arrangement of the more yielding rocks. They therefore belong to the same general class of valleys as those smaller ones carved by the headwaters of the tributaries to Georges Creek. They have been developed subsequent to the deformation of the strata and are not consequent upon original troughs and ridges.



VIEW FROM WILLS MOUNTAIN, SHOWING ESCARPMENT OF TUSCARORA SANDSTONE.

To the casual observer these subsequent valleys appear to have very uneven floors. The streams which now occupy the valleys often flow at the bottom of steep-sided ravines or gorges, a hundred or two hundred feet in depth in many cases, while their tributaries have cut up the surface very considerably. Thus there are very few interstream areas which afford even stretches more than two or three miles in extent. The general impression of the traveler is that the country is very hilly. If, however, one ascends one of the higher ridges, such as Shriver Ridge at Cumberland, or Pine Ridge north of Oldtown, the appearance of the valley topography is changed. The many small valleys and ravines drop out of sight. The hills are seen to be of nearly the same height and their level, slightly rounded tops seem to unite in a single broad, gently rolling surface. The even and level appearance which the valley floors thus take on is yet more marked when they are viewed from a point near the crest of one of the higher ridges, such as Warrior Mountain.

It is an interesting fact that the accordant hilltops in the one valley rise to the same level as do those in neighboring valleys. When the bounding ridges do not come quite to the Potomac, it is possible to trace their levels around the southern termination of the ridges from one valley to the next. The general level to which most of the hillcrests seem to rise is about nine hundred feet above mean sea-level, but this is not an absolutely constant figure. The general level rises to about one thousand feet towards the Pennsylvania boundary and increases gradually going westward to the same elevation in the vicinity of Cumberland.

The Drainage of the Ridge District.—The drainage of the district is entirely into the Potomac, and except in one case, that of Fifteen-mile Creek, the streams have a general southward direction parallel with the ridges. The courses of the streams, especially the smaller ones, are generally direct and closely parallel with the smaller ridges. The larger streams, however, do not adhere strictly to this general rule; but, in many cases, after flowing parallel with a larger ridge for some distance, make a sudden turn and cut through the ridge in narrow V-shaped gorges, after which they again turn southward and

resume their parallel courses. The most marked instances of these transverse gorges with parallel courses on either side are found in Wills Creek, which has to cross Wills Mountain before it reaches the Potomac, and Town Creek, which crosses Warrior Mountain in its upper course, and then, after flowing southward parallel with this ridge for a number of miles, again turns eastward and cuts back and forth through the northern extremity of Stratford Ridge. In the case of Fifteennmile Creek, the general direction of the stream is southeastward instead of southwestward, as is the case with all the other streams. This course takes the stream more directly to the Potomac, but compels it to cross several high ridges of resistant rocks instead of following one of the southwestward valleys on the yielding rock. Many of the small side-streams of this creek have sought out courses along bands of yielding rock crossed by the main stream, so that their courses are developed in conformity with the general direction of the streams of the district. Most of the streams of the district are characterized by somewhat meandering courses, particularly along their lower courses. The range of the meandering is often restricted to the valley limits as bounded by the smaller ridges. Such is the case with Evitts Creek. Sometimes, however, the stream is found to range beyond the minor barriers of the valley, in its course crossing from one side to the other of ridges of resistant rocks. Thus, Town Creek crosses the northern end of Stratford Ridge, composed of Oriskany sandstone, and Sideling Hill Creek meanders across a number of minor ridges between Town Hill and its mouth. These streams are all characterized by flood-plains or rich bottom-lands of moderate extent, and their meandering courses are, in part, due to their present flood-plain conditions. These bottom-lands, however, form the floors of meandering trenches from 50 to 200 feet in depth and bounded by steep, even precipitous sides. In spite of the graded channels now occupied by the streams, these deep and comparatively narrow trenches indicate recent down-cutting of the streams. It is probable, therefore, that the meandering courses, though in part accentuated by the present stream-cutting activities, in large part have been inherited from some former different condition of the streams.

These meandering lower courses seem to characterize chiefly the larger streams, and are best illustrated by Town Creek, Sideling Hill Creek and Evitts Creek. These characteristics are not confined to the streams flowing into the Potomac from the north, but are also to be found among the streams of West Virginia which empty into the same river in this district.

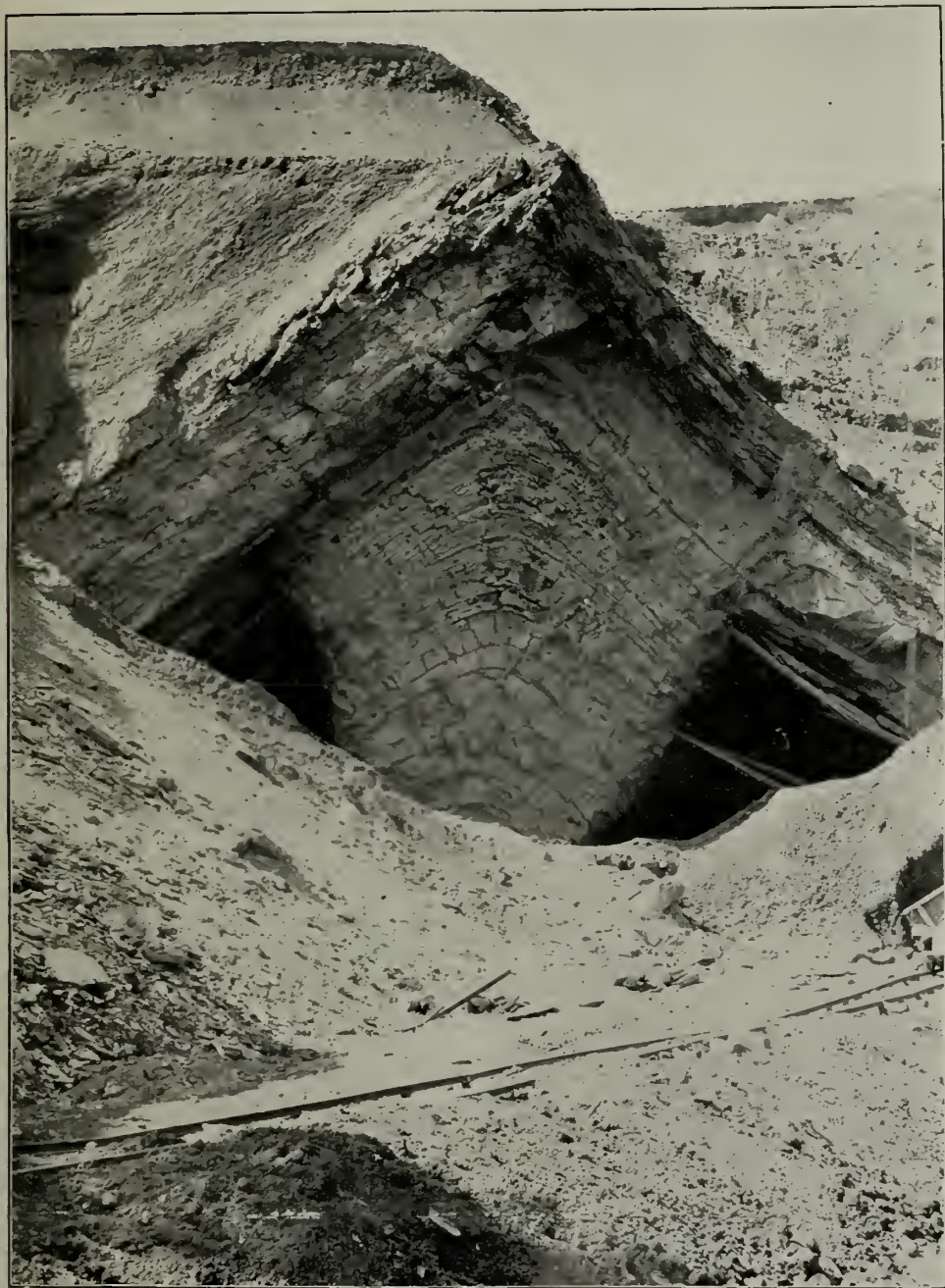
Another characteristic of certain streams is that of deflected lower courses. The most marked instance of this deflection is found in Big Spring Run, which enters the Potomac at Oldtown. This stream in its upper course flows southward along the western foot of Warrior Mountain. After reaching the southern extremity of the ridge, where it is about $1\frac{1}{2}$ miles from the Potomac, instead of continuing southward, it turns sharply around the nose of the ridge and follows a longer southeast course to Oldtown, four miles from the point where it would have entered the Potomac if it had followed the more direct course. Another example of deflection, though on a smaller scale, is found in the case of Maple Run, a small tributary which enters Town Creek opposite the northern end of Stratford Ridge. This stream flows southwestward until within a quarter of a mile of the creek, then, instead of continuing in this direction, it turns abruptly down stream and flows parallel with Town Creek for nearly a mile before entering it. A ridge about 100 feet high and with an elevation above sea-level of something more than 700 feet stands between the two streams throughout this distance.

Many of the streams, such as Sideling Hill Creek and Fifteenmile Creek show slight deflections up or down stream where they approach most nearly to the Potomac; but the only other well-marked instance showing considerable deflection seems to be that of the stream which flows into the Potomac opposite Paw Paw, W. Va. It rises between Green Ridge and Town Hill, flows southwestward for a mile and a half, until, when within the same distance of the Potomac, it turns sharply to the southeast around the southern end of Town Hill. After uniting with a small southwestward flowing stream on the east side of Town Hill, it continues its course southeastward to the Potomac. It is noteworthy that these deflections are all down stream

with reference to the Potomac, and that they are confined almost entirely to the larger streams.

The Structure of the Ridge District.—The structure of the Ridge District is very different from that of the Plateau District. Beginning with the arch on the west, of which Wills Mountain is the core, the same series of rocks appears again and again as one travels eastward across the county. The reason for this is that the rocks have been folded into arches and troughs, whose axes run northeast-southwest, and which are now cut across by the general surface of the district. Thus the edges of the cut strata appear on the surface as parallel or convergent bands. Where the axes of the folds are almost horizontal, the recurring bands of rock run parallel for considerable distances. When an arch or a trough rises or sinks, the bands draw closer together or diverge. Sometimes a great arching of the strata brings up above the levels of the stream-channels a bed of heavy sandstone, or of limestone flanked by sandstone. Then the streams are found to etch out surrounding strata and leave an anticlinal ridge. Again, in past ages a great trough may have buried a sandstone bed below the ancient stream-levels, thus preventing its removal. In such cases it often happens that the arches on either side of the trough will be removed completely, while the trough remains as the crest of a synclinal ridge. Between the anticlines and the synclines, the rocks come to the surface only as eastward- or westward-dipping beds. Thus the foundations are furnished for monoclinal, synclinal and anticlinal ridges and valleys.

Stream Adjustments in the Ridge District.—In discussing the topography of the Ridge District, the valleys have already been described and referred to as of subsequent origin. The streams occupying such valleys are always, in part at least, confined to them. In a number of cases in the Ridge District, it has been found that at one or more points certain streams will break their way across bounding ridges or mountains. They thus become, for a short distance, transverse in character and lose the close adjustment to structure which distinguishes a number of them. Many of the streams are characterized by adjusted courses, at least in so far as they are



ANTICLINE IN SALINA FORMATION AT CEMENT MILLS, CUMBERLAND.

related to the more important structural features. This class includes Evitts Creek, the stream draining Frog Hollow, the two streams on either side of Shriver Ridge, and one or two smaller streams. Some of these streams, notably Town Creek, while following adjusted courses so far as the major features are concerned, yet betray a rather general disregard for the minor variations in resistance pos-

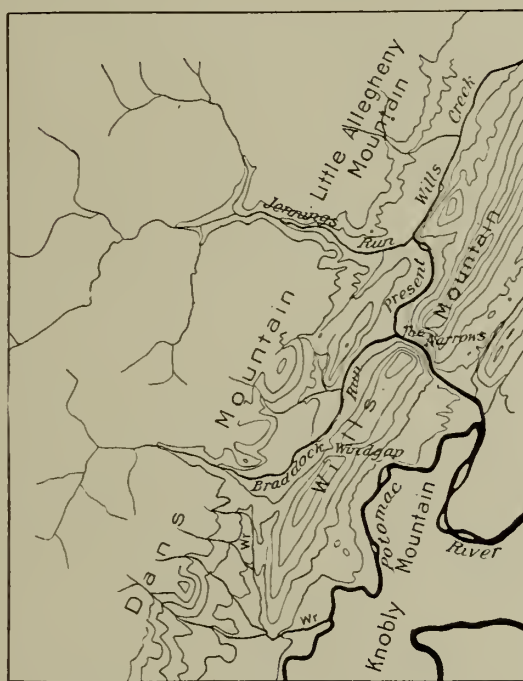


FIG. 1.—Present drainage in vicinity of Cumberland.

essed by many of the valley-making rocks. Most of the streams of any importance, however, embrace within single systems both adjusted and transverse features. Thus, Wills Creek follows yielding strata for a long distance, only to turn abruptly across Wills Mountain at Cumberland. Its principal tributary on the south, Braddock Run, also follows an adjusted course in part, but above Alleghany Grove it is located transversely across Piney Mountain. Jennings Run is similar.

The streams of the Ridge District are thus seen to show three different classes or degrees of adjustment to the arrangement of the underlying rocks. These three degrees are of double significance. At first sight it is evident that only the smaller and weaker, perhaps also only the younger, streams belong to the first class, which includes the streams closely adjusted to the smaller differences among the rocks. The streams belonging to the second class are in most cases among the larger, stronger streams of the district. The third class of streams, those showing besides adjustments, transverse characters even with respect to the strongest structural features, include only the strongest and largest streams of the county. Further study will show that in general these three degrees of adjustment among the streams indicate three epochs in the topographic development of the county. The smaller, more delicately adjusted streams indicate the most recent changes; the larger, more discordant streams point back farther and farther into the past.

To illustrate this, consider the geologically recent history of Town Creek. Just before the creek excavated the meandering trench which it now occupies, it flowed through a comparatively broad and gently rolling valley which extended from Warrior Mountain on the west to Polish Mountain and Green Ridge on the east. The general characteristics and indubitable former existence of this higher valley-floor are manifest to any one who will ascend one of the flat-topped hills or ridges. Standing on Pine Ridge near the gorge of the creek, for example, and looking thence across the remarkably accordant tops of all the neighboring hills, one may easily imagine the young gorge to be filled again with all the waste rock and earth which the streams have recently carried away. When such a restoration has been made, all the sharp inequalities of the present surface disappear. Stratford Ridge becomes a low, even insignificant mound, and Pine Ridge, together with many other hills and ridges, unite to form a common broad valley-floor, standing about 900 feet above mean sea-level near the Potomac and rising slowly to 1000 feet at the Pennsylvania line. This even, level valley must have been occupied by a winding stream, just as to-day small streams occupying similar valleys are found to be meandering and uncertain in direction.

The fact that to-day Town Creek is flowing in a deep trench indicates that its basin has been elevated, giving the stream opportunity to cut its channel deeper than it did at the time when it fashioned the broad valley now standing above it. The old elevated valley itself indicates that, during the period preceding the elevation just referred to, the land had remained stationary long enough to allow the stream to cut its channel as low as possible and the rains and rills to wear down the more yielding rocks of the valley close to the level of the stream. Even beds of more resistant sandstone, such as that found in Stratford Ridge, were well worn down by the rain and other agencies, so that, as the stream spread out its broadening flood-plain of bottom-land and shifted its course about, its channel stood across rocks which formerly made hills as often as across those which had always been valley-floors. When the elevation occurred which caused the creek to entrench itself, the stream cut down rapidly, keeping the windings which it had in its flood-plain condition. To-day, therefore, the stream shows a general course which is independent of the minor variations in resistance found in the rocks of its broader valley. Smaller streams which have grown since this elevation occurred have taken advantage of the various kinds of rocks and have developed most strongly along those which have been the easiest to remove. As these streams started later, they have not been able to attain as great a size as have those streams which were in existence before the elevation took place.

In some cases the development of these younger, smaller and better-adjusted streams has resulted in decided changes in drainage lines. A striking and interesting example is found in Braddock Run, of the Wills Creek system.

The period of lower level which permitted Town Creek to carve such a wide, evenly-floored valley, gave Wills Creek similar opportunity. At that time, however, Braddock Run did not pursue its present course northeast from Allegany Grove, but ran eastward to join Wills Creek or perhaps the Potomac, after cutting across Wills Mountain through a gap now seen about one mile northeast of Allegany Grove. The present valley between Piney and Wills mountains

is but the successor of a wider valley which in those days had been worn out on the same yielding, soluble limestones and shales that are found there as valley-makers to-day. This former valley was due to the work of two small streams, one (*b*) flowing northward emptied into Wills Creek just where it turned to cross Wills Mountain, the other (*a*) flowing southward joined Braddock Run near where it also crossed the same sandstone barrier.

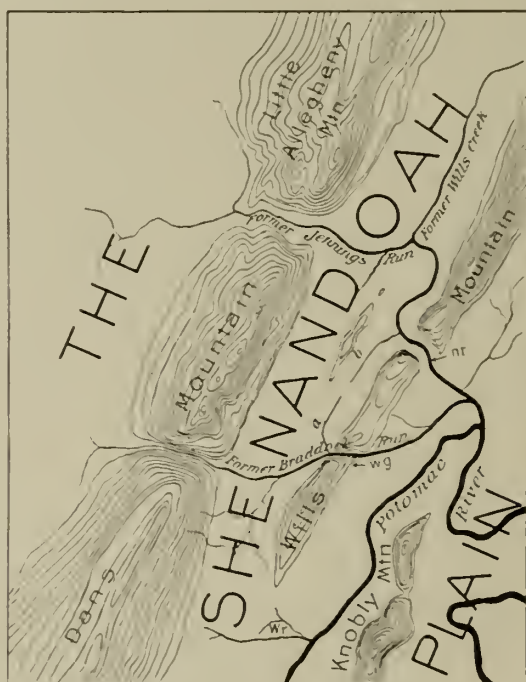


FIG. 2.—Drainage about Cumberland, on Shenandoah Plain.

At that time, both Wills Creek and Braddock Run were smaller than they are to-day; still Wills Creek must have been the larger, and therefore the more powerful, even then, for it had in addition to Jennings Run a considerable tributary from the north. The stream arrangement at this time was as shown in Fig. 2. When the elevation occurred, as a result of which both Town Creek and Wills Creek deepened their channels, the two streams *a* and *b* also went to work

with renewed vigor. These two tributaries were limited in their rates of down-cutting by the rates at which their two main streams, Wills Creek and Braddock Run, could reduce their channels. The superior power of Wills Creek, due to its greater size, would soon become apparent, and as a result, *b* would have the advantage of a lower outlet than *a*. This advantage possessed by *b* resulted in the gradual but continual shortening of *a* by the capture of its headwaters. Finally, when Wills Creek had cut its gorge down close to its present level, and *b* had lowered its channel in a corresponding degree, *a* was entirely extinguished. Braddock Run, which had been long delayed in its gap-cutting by the heavy sandstone of Wills Mountain and by its own small volume, was then tapped by the headwaters of *b* and led out along its present course into Wills Creek (see Fig. 7). Thus the gorge cut in Wills Mountain by Braddock Run has come to be abandoned and is but a wind-gap, while the activity of a small subsequent stream has caused a marked change in the course of the Run.

A yet more marked change in course is now threatening Braddock Run. Warrior Run (Fig. 1, *Wr.*), which empties into the North Branch at Brady, has been rapidly working its way around the south end of Wills Mountain, pushing up in between it and Dans Mountain until at the present time the headwaters at Winchester reach within a mile of the larger stream where it turns northward at Allegany Grove. The steep slopes and deep, sharply incised channels of the Warrior Run headwaters contrast very strongly with the open, gently sloping and much higher valley of Braddock Run. This contrast is very clearly shown by the contour lines on the topographic map of the county. Steep slopes, whether found on hills or in stream channels, indicate rapid wearing away of the land surface, while mild and gentle slopes always indicate localities of more gradual wasting. In the present case it is clear that the headwaters of Warrior Run are rapidly (in a geological and geographical sense) encroaching upon the domain of Braddock Run. Already the former stream has reduced its valley to levels several scores of feet below the levels of corresponding points on the northern side of the saddle-like divide, and it can be

but a short time, geologically, before the working backward of its headwaters will intersect and underent the channel and valley of the much less active, though larger, stream. The upper portion of Braddock Run will then be drawn off to the North Branch via Warrior Run, while the lower course, much shrunken in volume, will still flow into Wills Creek.

The reasons for the superior power of Warrior Run are not difficult to find. In the first place Warrior Run, which falls 470 feet in 4 miles, has a much steeper slope than has Braddock Run, which falls the same vertical distance only after flowing for about 7 miles. Warrior Run therefore has much more power to cut down its channel and to push back its headwaters. In the second place, by reason of the rapid plunging of the Wills Mountain anticline or arch, Warrior Run is able to avoid crossing the resistant sandstone of that mountain and has made its course entirely on the yielding rocks lying above. Thus this stream, finding less resistance offered by the rocks it crosses, can rapidly lower its grade, while Braddock Run and Wills Creek, opposed in "The Narrows" by the sandstone, are continually delayed.

In studying the minor discordances of Town Creek and Wills Creek, the younger gorges of these streams were supposed to have been refilled by the materials carried from them, thus restoring the former wide valley-floors between the highest ridges and mountains of the district. There are many hills and ridges in neighboring valleys whose accordant tops rise to elevations corresponding with those in the two valleys mentioned. This suggests that similar restorations carried on at large would produce a number of similar and even confluent valley-floors. Such a general restoration, indeed, would reveal the fact that the valleys were etched out and leveled, at about the same time and to the same depth, over a very wide expanse of territory. Because the limestone valley of the Shenandoah best shows this old lowland plain, the epoch during which it was produced is sometimes called the Shenandoah Plain Epoch, and the plain itself the Shenandoah Plain.

When one attempts to unravel the reasons for the greater dis-

cordances which exist between the structure and the larger streams of the Ridge District, he must look back to periods in the topographic history yet earlier than the Shenandoah Plain Epoch. Here, again, the first step may be a restoration of earlier forms by supposing that the rocks which have been removed are back in place. Restore them not only to the level of the Shenandoah Plain, but beyond to the general levels of the yet higher ridges and mountains. The result is even more striking than in the first case. Instead of a series of comparatively even-bottomed valleys lying between well-marked ridges, a broad gently rolling surface is found to have existed. It was crossed from south to north by long low ridges, whose locations corresponded with the present crests of Dans Mountain, Savage Mountain, Martin Mountain, Warrior Mountain, and perhaps Town Hill and Sideling Hill. Between these divides were broad shallow valleys coinciding in general location with the present larger valleys. The great areal extent of this old almost plain surface is evidenced by many level mountain crests which rise to the same general altitude. One of these, Schooley Mountain, in Pennsylvania, has given its name to the general feature.¹

The restoration assumed would bury the present sandstone crest of Wills Mountain several hundred feet deep beneath a series of shales and limestones which are now found forming valleys and low-lying areas. This fact makes it probable that in the period being treated, the area between Dans Mountain and Martin Mountain was a broad level valley occupied by the predecessor of the present Potomac. At that time it would have been easy and natural for a moderate-sized tributary, growing westward from the Potomac at Cumberland, to develop a branching system of streams across the buried crest of Wills Mountain and even to push its headwaters a short distance back behind the then low-lying ridge of Dans Mountain and Piney Mountain. This scheme of the drainage is sketched in Fig. 3.

The stream arrangements shown in this sketch must have been completed rather near the close of the long period of erosion which

¹ For more detailed description of the Schooley Plain see Maryland Weather Service, vol. i, pp. 119-121, 1899.

produced the Schooley Plain. This is evident, because the discordant position of Wills Creek and its tributaries across Piney Mountain could best be obtained at a time when the ridges of resistant rocks were well reduced and probably rather deeply covered with a mantle of disintegrated rock. The course taken at this time by the Potomac across Dans, Knobly, Martin and other mountains is also evidence of the low, mild character of the topography.



FIG. 3.—Drainage about Cumberland, on Schooley Plain.

The stream-revival which caused the etching out of the Shenandoah, the Town Creek, and other valleys, also started Wills Creek on a period of rapid down-cutting. In the course of the first rapid trenching of the stream-channels, the buried crest of the Wills Mountain arch was notched by Jennings Run and Braddock Run. The further removal of the overlying beds exposed the whole long arch of sandstone. Finally, when the valleys and notches had been reduced



GEORGES CREEK VALLEY, NEAR BARTON.

to the general level of the then low-lying Shenandoah Plain, Wills Mountain stood out as a long ridge whose crest was cut in two places by watergaps (Fig. 2, *Wg* and *Nr*). One of these is still a watergap and is occupied by Wills Creek, *i. e.* it is "The Narrows." The other notch is now the windgap from which Braddock Run has been diverted (Fig. 7). During this cutting down to the Shenandoah Plain, Jennings Run developed a small subsequent tributary along the easy path between Little Allegheny and Wills mountains. This stream has in later time developed more rapidly than its older brothers, Jennings Run and Braddock Run. This is for the reason that it is located along yielding rocks, while the other branches have to contend with both Pocono and Pottsville sandstones. It is now the main stream of Wills Creek.

TOPOGRAPHIC HISTORY.

STAGES IN THE TOPOGRAPHIC HISTORY.

In the foregoing discussion of the topography of Allegany county, certain features have been referred to as if they were stages or milestones in the series of changes which the surface features of the county have been passing through. It will be a convenient way of summing up and correlating the features already considered if the several stages of topographic history are taken up in order and briefly considered. Six stages may at present be clearly distinguished. They may be named:

1. The Present or Channel-cutting Stage.
2. The Terrace-forming Stage.
3. The Shenandoah Plain Stage.
4. The Schooley Plain Stage.
5. The Appalachian Mountain Stage.
6. The Rock-forming or Paleozoic Stage.

THE PRESENT STAGE.

At the present time all the streams of Allegany county are at work fashioning their channels. In many cases they are putting the finishing touches to the even slopes which they prefer to flow on, and some

streams have even completed this slope in places. All the streams, however, are here and there interrupted by rapids and shallows, which show that, in spite of the plains or bottom-lands built during floods, they have not yet perfectly graded their channels. The Potomac has reduced its channel to so flat a slope that the low dam for the canal at Cumberland backs up the water for a distance of two miles upstream. But even this large stream, flowing eight or ten feet below its flood-plain during its ordinary stages, has many unreduced ledges in its channel.

The present downward tendency of the streams may be traced back to the close of the Shenandoah Plain period, for it has resulted in the carving out of trenches below the general level of that plain.

THE TERRACE-FORMING STAGE.

This down-cutting has not been uninterrupted, however. Bordering the lower courses of all the larger streams of the county, and of many of the smaller streams, are two well-defined stream-terraces. Such stream-terraces indicate former positions of the stream-bed, and when found along the banks of a stream indicate that its vertical cutting has been interrupted for a while. Instead of cutting vertically, the stream may have cut horizontally, or even stopped cutting and begun to build up by depositing gravel and sand.

The stream-terraces in Allegany county are usually gravel-strewn, often deeply so; but never consist wholly of gravels and sand. Always beneath this looser covering can be found smooth, even surfaces which were cut across the bedding of the rocks by the streams and later strewn with gravel and sand. The higher terrace has an elevation of about 800 feet along the Potomac above Cumberland, and the one next below stands at about 650 or 700 feet. This lower one is generally better defined, particularly at Cresaptown and Cedar Cliff and above Riverside station, on the West Virginia Central and Pittsburgh Railway. The 800-foot terrace forms the cobble-strewn hills overlooking Cumberland and South Cumberland, while the town is built on the lower one.

These terraces, with one or two lower and minor ones in the imme-

diatc vicinity of the streams, may be traced along the Potomac from one side of the county to the other, and also up the larger streams flowing into it. Going up the tributary streams the terraces naturally rise, since the smaller volumes of these streams will always leave their channels steeper than that of the Potomac. The levels also seem to draw together somewhat. The best traces of the terraces can be found near Allegany Grove (1000 feet) on Braddock Run, about Corriganville, and between that place and Ellerslie (750 feet), on Wills Creek. They also occur along the lower courses of the streams joining the Potomac at Oldtown (720 feet); and all along Town Creek at about 680 feet.

Since these terraces are both cut out of the rock and slightly built up also, it is evident that they are the indices of stages in the post-Shenandoahan down-cutting. Just why they were formed is not yet clear. They may indicate a temporary loss of speed due to a slight westward tilting of the river channel and a consequent cessation in downward cutting accompanied by deposition of gravels. Or it may prove to be the case that these benches indicate the positions of the land during periods of temporary rest when the streams really cut down to their lowest possible grade—the rock-plains of the terraces. Whatever may be their final explanation, these terraces are still significant as indicating that there has not been a steady downward tendency of the streams, but an intermittent one. Periods of rest or of sluggish work, accompanied by lateral cutting, succeeded periods of active vertical attack.

THE SHENANDOAH PLAIN STAGE.

Immediately preceding the uplift which inaugurated the recent gorge-cutting and terrace-forming activities, there came a period of some length during which not only Allegany county but the whole Atlantic slope stood fast with reference to sea-level. This gave the streams the opportunity to etch out valleys on the yielding limestones and shales, while they left the more resistant rocks standing. So long a time was allowed that the valleys thus determined by yielding rocks were worn down very low indeed. Their surfaces were almost

smooth, even plains: the streams began to wind back and forth across flat bottom-lands and paid no attention to the rocks which, earlier, had formed low ridges in the valleys. The later gorge-cutting dissected these level valley-floors, but many hill-tops and ridges between the streams still retain a portion of this old intermontane plain. To it belong the tops of many hills along Town Creek, Evitts Creek and Fifteenmile Creek, reaching elevations of about 900 feet above sea-level.

Along the meandering course of the Potomac, also, are many hills rising to 900 or 1000 feet, and lying between still higher ridges. They are most noticeable between Paw Paw and Little Orleans, where they have an elevation of about 900 feet. About Cumberland, also, the old valley-level is preserved in the crest of Shriver Ridge (1100 feet) and the long flat spur (1115 feet) forming the north end of Knobly Mountain. These traces of the Shenandoah Plain, found in the hilltops bordering the meandering and trenched Potomac lend support to the theory that these meanders are inherited from flood-plain meanders of the Shenandoah Plain stage. The fact that the meanders are not found cutting across ridges which rise above the Shenandoah Plain is additional evidence in favor of this theory.

The Shenandoah Plain period also gave opportunity for the further and closer adjustment of many streams in existence at the opening of the period. This was notably the case with Wills Creek, Fifteen-mile Creek and Town Creek. Numbers of smaller streams which came into existence during this period started on yielding rocks and in later times have simply continued along their originally subsequent courses. Towards the close of the period, however, many streams lost their finer adjustments by reason of their flood-plained condition. The best instances of this have been referred to already, viz., Town Creek and Fifteenmile Creek. Other smaller streams seem to have been thrown out of adjustment by the influence of the broad flood-plain along the Potomac. This is notably the case with the streams entering near Oldtown and also with Sideling Hill Creek. These streams instead of joining the Potomac by the most direct line, which is the rule, are deflected down stream when within two miles or less of the river.



THE NARROWS OF WILLS CREEK, NEAR CUMBERLAND.

THE SCHOOLEY PLAIN STAGE.

The gorge-cutting period was inaugurated by a general warping and uplifting of the Shenandoah Plain, the uplift being greatest in the southwestern districts and least in the east. The Shenandoah Period was inaugurated by a closely similar uplift of the Schooley Plain. The Schooley Plain was produced in the same way as the Shenandoah Plain. The main difference between the two features is the absence from the Schooley Plain of extensive mountain ranges or ridges looking down upon it. This resulted simply from the fact that the earlier period was of much longer duration, so that opportunity was given for the complete reduction to the general level of the zones of resistant rock. Of this former surface there are now numerous remnants to be found in the long even crests of the higher ridges in the county. On account of the much greater erosion which this older plain has suffered, its traces are much fewer than are those of the younger Shenandoah Plain. They are preserved only by the most resistant rocks of the county; but they are sufficient to show that the old surface was widespread and imposed upon all the rocks of a large area regardless of differences in resistance.

By the time that the agents of denudation had established this surface, all the streams had adjusted themselves to the structures revealed by the widespread planing off. Probably all the well-grown streams of the time had meandering courses, except the youngest streams, initiated towards the close of the period which would have had more direct and vigorous paths. Among these younger streams were probably found the forerunners of Jennings Run, Braddock Run and Fifteenmile Creek, as their present discordant courses are at variance with features which were then much less significant than they are to-day. The other streams, such as Evitts Creek and Sideling Hill Creek, probably existed during the Schooley Plain period as smaller, adjusted, subsequent streams flowing into the contemporary representative of the North Branch of the Potomac. Wills Mountain lay several hundred feet below that surface, not yet revealed by the erosion which followed upon the uplifting of the plain. Town Hill also was still in embryo, but for a different reason.

The hard sandstone which was to form its crest was not buried beneath many feet of overlying rocks, but lay almost at the surface of the plain. It had formed the floor of a trough of rock which had been folded down so low that it escaped removal in the general planing off which resulted in producing the Schooley Plain. Thus when re-elevation revived the streams and enabled them to etch out the softer rocks, this long slab of sandstone still remained to protect the rocks beneath it. A similar reason may be found for the preservation of the coal-beds of the Georges Creek basin. These would not now be available had it not been for the fortunate accident whereby the broad synclinal trough of the Plateau District was so greatly depressed below the general level to which the whole county was reduced. Because of this depression, the coal-formations were not worn away from this district. Since their position was higher over the western portion of the county, they were all removed during its reduction to the Schooley Plain.

THE PALEOZOIC PERIOD AND THE APPALACHIAN REVOLUTION.

Thus far one may read the history of Allegany county topography from existing surface features. The earliest stage related in that history, the Schooley Plain, cannot be the beginning, however. The very folds and breaks in the great series of strata which form the foundations and skeleton of present topography, themselves suggest the possibility of a time, preceding all the periods just recounted, when the earth's surface was cut into valleys and mountains which were due directly to the great folds now traceable only where valleys cut down across them. If there ever was such a time and such topography, the scenery must have been much grander than it is to-day. Thousands upon thousands of feet of rock have been removed since the folding began, so that the folds themselves must have given rise to mountains five or six times as high as the present Appalachians with some correspondingly deep valleys between. These would have been the earliest mountains and valleys.

It is probable, however, that the surface which would have thus appeared, never existed in an altogether unmodified state. As soon

as the folds appeared above the sea, the rain and wind and frost would have begun to wear away their surfaces, cut out gullies and cross-valleys, rapidly changing the new surface. Thus the earliest land topography here would have been at best, the original folds, troughs and ridges, modified by the rain and other denuding agents.

These folds were produced in rocks of horizontal strata deposited on the floor of a great sea. This sea washed the western shores of a land-area located about where the present Blue Ridge is, and it was the waste washed from this land which formed the rocks of the sea-floor. According to geological chronology, those rocks are said to be of Paleozoic age, and the sea in which they were deposited may be called the Paleozoic sea. This period, during which the present rocks were being deposited in the Paleozoic sea, is the earliest one of which there is *any* trace in Allegany county. In fact, it was the beginning of the geographic history of the county. The great folding and upthrusting of the horizontal strata on this old sea-floor put an end to further accumulations by raising them above sea-level. The change was so complete and tremendous and comparatively rapid that it is often spoken of as a revolution. Since it resulted in the building up of the forerunners of the Appalachian Mountains, it is usually referred to as the Appalachian Revolution.

It should be remembered, however, that the present Appalachians resulted only indirectly from this so-called revolution. The immediate predecessor of the present topography of Allegany county was a broad, almost featureless plain, and the mountains, ridges, valleys and cliffs of to-day have all resulted from the wearing away of areas of yielding rock and the continuance of the resistant ones standing out in relief.

THE GEOLOGY OF ALLEGANY COUNTY

BY

CLEOPHAS C. O'HARRA

INTRODUCTORY.

Particular attention is given in the following pages to the stratigraphy, structure and areal distribution of the various formations exposed in Allegany county; the processes and conditions under which the sediments were deposited: and the forces that have operated in bringing about the present attitude of the strata. A brief review of previous work is given, and a bibliography is added. Only such general references to the paleontology, physiography and soils of the region have been made as are necessary to give a clear understanding of the geological features since these branches are more fully discussed in other places.

GEOGRAPHIC AND GEOLOGIC RELATIONS.

The situation and boundaries of Allegany county have been described in earlier pages. Although bounded on the north and west by straight lines whose combined length approximates only 50.8 miles, the entire periphery is about 145 miles, the amount being very much increased by the tortuous channels of the Potomac river and Sideling Hill Creek.

The county contains several mountains of importance. Naming them in order from the east, they are: Town Hill, Green Ridge, Stratford Ridge, Polish Mountain, Warrior Mountain, Tussey Mountain, Martin Mountain, Collier Mountain, Evitts Mountain, Nicholas Mountain, Shriver Ridge Mountain, Wills Mountain, Allegheny Mountain and Dans Mountain. The last two, which may really be

considered as one mountain, and which are alluded to in this paper as the Dans-Allegheny Mountain, form a part of the great Allegheny Front. Tussey Mountain dies out almost immediately after entering the county from Pennsylvania, and Evitts Mountain becomes obliterated nearly as quickly. Other ridges and hills of less geological importance are named on the map.

The drainage of the county is wholly to the south. Among the more important streams entering the Potomac are the following: Sideling Hill Creek, Fifteenmile Creek, Town Creek, Martins Spring Run, Colliers Run, Evitts Creek, Wills Creek, Georges Creek and Stony Run. Among the other streams, lying wholly or partly within Allegany county, whose waters eventually find their way into the Potomac are Flintstone Creek, Murley Branch, Jennings Run, Braddock Run, Moores Run, Jackson Run, Hill Run, Elk Lick Run, Matthew Run, Neffs Run, Winebrenner Run, Staub Run, Wrights Run, Squirrel Neck Run, Koontz Run, Laurel Run, Bartlett Run, Mill Run, Rock Gully Creek, Maple Run, White Sulphur Creek, Piney Ridge Run. Flintstone Creek, Murley Branch and Maple Run flow into Town Creek; Jennings Run and Braddock Run flow into Wills Creek; Rock Gully Creek flows into Evitts Creek; White Sulphur Creek and Piney Ridge Run flow into Fifteenmile Creek; while all of the others named enter Georges Creek.

The area covered by Allegany county forms an integral part of the Appalachian Province, hence an accurate and exhaustive study of the geology of the county can be made only by adequate reference to the conditions governing the complete geologic history of the entire province. The province itself is composed of three genetically related physiographic divisions, the principal features of which have been brought about by geographic conditions that no longer exist.¹ The eastern division is a part of the ancient continent of Appalachia, a land-mass of uncertain area from which most of the sediments of the Appalachian Province were derived. The western limit of this division of the province is now represented by the Blue Ridge.

¹ Willis, Bailey. The Northern Appalachians, Geographic Monographs, vol. i, 1895.

Lying to the west of Appalachia there was a great inland sea in which the sediments from this ancient continent were gradually laid down. The littoral zone of this mediterranean sea having received many thousands of feet of various kinds of sediments, was from time to time affected by powerful organic movements, possibly not yet ceased, the result of which has been to bring the formerly almost horizontal beds into a greatly folded condition. This old littoral zone, now constituting the central physiographic division of the province, corresponds to what is sometimes known as the Greater Appalachian Valley, using that term in its wider sense to include the area between the Blue Ridge and the Alleghany Front. Along the outskirts of the littoral zone the strata were much less influenced by the enormous forces which so disturbed the central and eastern divisions; and, although considerably elevated, they have, as a rule, been left in a more nearly horizontal position. This part which now forms the Alleghany Front and the Alleghany Plateau constitutes the western physiographic division of the Appalachian Province.

Structurally, the area which is covered by the central and western physiographic divisions as above defined, is divided somewhat differently. According to the structure, two divisions are recognized, but the line of separation falls much farther east. In Maryland, the western structural division known as the district of *open* folding is limited on the eastern side by North Mountain, while the western limit extends beyond the western borders of the state. East of North Mountain lies the structural division known as the district of *close* folding. In Maryland it occupies approximately the position of the Hagerstown Valley.

Structurally, then, Allegany county lies wholly within a single district, that of open folding. Physiographically, it includes parts of two divisions, viz., the Greater Appalachian Valley and the Alleghany Plateau. Stratigraphically, it is not referable to any well-defined district or division. The stratigraphic features are, in a sense, much the same as for all of the area west of the great limestone valley. Furthermore, the various structural features, as well as the contacts of the various formations found in the county, extend in many

instances without a break or disappearance for miles beyond the limits of the county. It will thus be seen that the county is not a geological unit and has not been so considered in this paper. However, lying along the Potomac and favorably situated for the display of the structural, physiographic and stratigraphic features of a continuous series of sediments, from the middle Silurian to the late Carboniferous or Permian, rich in easily accessible and well-preserved fossils, and containing also in the western part large deposits of economic importance, the county has for many years been known as a region of peculiar interest, and one deserving careful geologic study.

HISTORICAL REVIEW.

The most prominent physiographic features of Allegany county have long been known. Natural facilities for a careful study of the rocks have always been good, and in addition, especially favorable opportunities have at times been provided by means of the various extensive improvements made for military and commercial purposes. During the middle of the eighteenth century military expeditions to Fort Cumberland and beyond necessitated the construction of a good road from the Atlantic coast to the Ohio valley. George Washington, in a letter to Colonel Bouquet, dated "Camp at Fort Cumberland, 2, August, 1758," says that the first good road for commercial intercourse between the traders of Virginia and Pennsylvania and the Indians along the Ohio was by way of Wills Creek [Cumberland], which place had been selected by intelligent Indians who had been hired to choose the most favorable route of communication. He further states that the Ohio Company in 1753 opened the road at a considerable expense, and that in the following year his own troops greatly repaired it. In 1755 it was widened and completed by General Braddock to near Fort Duquesne. Early in the present century the National Road was surveyed and constructed, the military road being in part utilized for this purpose. Later extensive surveys were made for the Chesapeake and Ohio Canal and for the Baltimore and Ohio Railroad, the latter reaching Cumberland in the year 1842 and



FIG. 1.—TOLL-HOUSE ON THE NATIONAL ROAD.



FIG. 2.—PULP-MILL, NEAR WESTERNPORT.

the former in 1850. These surveys, references to which are given in the bibliography, added much to the general knowledge of the physiography and gave considerable detailed information concerning the character of the rocks and their folded condition, but there appears to have been little attention given to the purely scientific study of the geology of the area.

During the autumn of 1831, Samuel Whyllys Pomeroy traveled through the county and made some hasty observations on the geology along the National Road, particularly in the vicinity of Cumberland and Frostburg (2).

In "Some Notices of the Geology of the Country between Baltimore and the Ohio River, with a Section illustrating the Superposition of the Rocks," by William E. A. Aiken, published in the *American Journal of Science*, volume xxv, 1834, we have one of the earliest attempts to explain the structure of the mountains and to correlate the various kinds of rocks (3). Unhappily, Mr. Aiken's observations in Allegany county were so meagre that many of the conclusions were necessarily faulty and little definite advance was made.

In the same year, 1834, J. T. Ducatel, State Geologist, and J. H. Alexander, State Topographical Engineer, in a "Report on the Projected Survey of the State of Maryland, pursuant to a resolution of the General Assembly," give general statements concerning the geology of the county (4). Mention is made of the mineral and warm springs near Flintstone, and of the Frostburg coal-field. Much of the information was taken from the collection of reports and letters of the engineers of the Chesapeake and Ohio Canal.

In his "Report of a Geological Reconnaissance made in 1835 from the seat of government by way of Green Bay and the Wisconsin territory on the Coteau du Prairie, an elevated ridge dividing the Missouri from the St. Peters river," G. W. Featherstonhaugh gives considerable geological information concerning Allegany county (8). He traveled under the direction of the United States government and passed through the county while en route westward, evidently entering the county by the National Road. East of Cumberland he

makes little mention of the rocks, but refers to fossils found in the limestone at Flintstone. This limestone he erroneously correlates with the Carboniferous limestone further west. Shriver Ridge is mentioned as being composed of shale and limestone with "*producta*," "*spirifer*" and "*cardia*." The Wills Creek gorge he describes with considerable detail, and gives a sketch of the same. A crude hypothesis for the anticlinal structure of Wills and neighboring mountains is also given. From Cumberland he went to Frostburg, thence down the Georges Creek valley to the Potomac, which he ascended beyond the mouth of Savage river, then returned along the Potomac to Cumberland. He speaks briefly of the Georges Creek coal area and believed that the coal-bearing strata were deposited after the movement which produced the folding to the east.

About this time much interest began to be manifested in the coal, iron, cement, and fire-clay of the coal basin. With the prospect of an opportunity to ship by rail and canal, a greater interest was aroused in the mineral wealth of the county, various mining companies were incorporated, and reports began to appear giving more or less accurate descriptions of the geology of this part of the state. Some of these papers show the result of original work; but not a few were only compilations from the writings of others.

In a report dated October, 1836, to the Georges Creek Coal and Iron Company, one of the earliest companies to develop the mineral resources of the Georges Creek basin, J. H. Alexander and P. T. Tyson give two maps of portions of the Georges Creek area, one columnar section known as the "Dng Hill Section," one structure section and various other details (10). Two months later, Mr. Ducatel, the State Geologist, in his official report to the Governor of Maryland, included a description of the Frostburg coal-field in which the columnar section made for the Georges Creek Coal Company is given. In this report there is also given a carefully prepared hachured map of the entire area on which the various streams, towns and mines are located and named. Frostburg is given on the map as Frost Town, and the coal area is called after it.

During this year, 1836, the State Topographical Engineer, J. H.

Alexander, directed the execution of a chain of triangles with a plane-table survey over a part of the Georges Creek area. The work of this survey was accomplished at individual expense, but the results were generously offered for the use of the state survey.

During the same year, 1836, George W. Hughes made a report to the Maryland Mining Company in which he gives the result of an examination of the coal measures and iron ore deposits belonging to the company (9). The paper includes various analyses and columnar sections.

In this year also, James C. Booth studied the area and published the results in a short paper entitled "Report of the Examination and Survey of the Coal-fields and iron ores belonging to the Barton and New York Coal Company" (7). The next year, 1837, further notes by Mr. Booth, as well as short reports by L. Howell and John Powell were published for the same company.

On February 9, 1837, Professor Philip T. Tyson read before the Maryland Academy of Sciences and Literature a paper entitled "A description of the Frostburg coal formation of Allegany county, Maryland, with an account of its geological position" (12). Later this was published in the Transactions of the Society. With the description of the area one columnar section and two structure sections are given.

In the same year, D. B. Douglas spent three weeks in the coal-field. He made a columnar section and studied the physical and chemical character of the coals (15).

The following year, 1838, Benjamin Silliman made a brief study of the area in the employ of the Maryland Mining Company (16).

During the year 1840, the State Geologist, J. T. Ducatel, made a study of the physical geography, geology and agricultural and mineral resources of Western Maryland (23). The results of his observations were published in the "Annual Report of the Geologist of Maryland, 1840" (23). This is a paper of 46 pages, 30 pages of which are, however, taken up with a study of the area now included in Garrett county. Mr. Ducatel's report was the first published document of any considerable length which reviewed with reasonable accuracy the

geology of the entire county. It includes the geology and physical geography with remarks on the actual agricultural condition, prospects and resources, as well as information concerning the mineral wealth of the county and the best means of developing it. Two columnar sections of the coal-fields, one structure section along the "Cumberland and National roads," and a topographical map of Allegany and Washington counties on the scale of 1:400,000 are given.

The year 1842 is one of particular interest on account of Sir Charles Lyell's visit to the county. In May of that year he passed through the county by way of the National Road, stopping at Cumberland and Frostburg. In the vicinity of the latter place a number of plants and marine shells were obtained from the coal measures. Among the shells, he mentions *Bellerophon*, *Euomphalus*, *Nucula*, *Loxonema* and *Producta*—seventeen species in all. Of the plants, Bunbury, who described them, gives *Danaeites*, *Neuropteris*, *Pecopteris*, *Lepidodendron*, *Sigillaria*, *Stigmaria*, *Asterophyllites* and *Calamites*—twenty species altogether (30).

In 1844, the classic paper "A Report to the Navy Department of the United States on American coals applicable to steam navigation and other purposes," by Walter R. Johnson was published (27). Coals from several Maryland mines were among those studied.

During the next few years little original investigation was carried on in the county, but this period marks the time of much of the valuable work done by the illustrious brothers, W. B. Rogers, Director of the Geological Survey of Virginia, and H. D. Rogers, State Geologist of Pennsylvania, who published many reports giving valuable information concerning the geology of their respective states, much of which information was extremely helpful in interpreting the geology of Allegany county.

In 1852 reports were published by the Phoenix Mining and Manufacturing Company which included a "topography of the mineral regions" by Professor Forrest Sheppard and a report on the topography and structure of the coal-field by Professor C. U. Shepard (33).

Two years later, 1854, George W. Hughes, President and Engineer of the Hampshire Coal and Iron Company, published a report dealing especially with the lands controlled by his company (34).



VIEW OF NORTH BRANCH OF THE POTOMAC, NEAR KEYSER, W. VA.

In 1855, Robert G. Rankin published a report on the economic value of the semi-bituminous coal of the Cumberland basin (36). This is an excellent paper in which the author gives a description of the basin, analyses, use and origin of the coal and the facilities for transportation.

In 1859 a great advance was made in the historical study of the rocks. Professor James Hall, State Geologist of New York, who was so exhaustively studying the Paleozoic fossils of his own state, made also from time to time large collections from several of the states to the west and south. In September, 1856, he visited Cumberland, made some geological examinations and studied the extensive collection of Mr. Andrews. Later Professor Hall purchased Mr. Andrews' collection and continued his studies upon it. Three years after his visit volume 3 of the *Paleontology of the State of New York* was published. In this volume sixty-three species are described from Cumberland and vicinity, many of which are figured. Several of the subsequent paleontological reports published under the direction of Professor Hall also contain descriptions and figures of numerous species from the same locality.

The year 1860 marks the appearance of the state geological map by Philip T. Tyson, published in his official report as State Agricultural Chemist (40). This map, which is on the scale of twelve miles to the inch, represents the first serious attempt to arrange in accurate detail the various geological formations in Allegany county. With the map there are three structure sections, one of which crosses the county from west to east near the Maryland-Pennsylvania line.

During the summer of 1868, Professor James T. Hodge of Boston, studied the coal basin and made an extensive survey of the coal properties (47). In his report, published the following year, he gives much attention to property lines, but also discusses the coal region as a whole, including the drainage of the basin, access to the coal-bed, system of mining, area covered by the Big Vein and product of Big-Vein coal to the acre. To the property-owner this has been a most valuable work, but the report is now almost wholly inaccessible.

In 1874, Professor James Hall published his paper on "The

Niagara and Lower Helderberg Groups: their relations and geographical distribution in the United States" (51). In this paper brief but valuable references are made to the relations of the groups as they occur at Cumberland.

In 1878, under the direction of the United States Navy Department, B. F. Sherwood, Theodore Zeller and Henry L. Snyder made careful experiments on various coals, including the Frostburg coal (58). Particular attention was given to the physical structure of the coal, to its action while burning, to its heat-producing power and to the residual ash, clinker and soot.

In 1878, Professor J. J. Stevenson published two articles in the American Journal of Science on the geology of portions of Pennsylvania, Maryland and West Virginia. In one article particular mention is made of the terraces in Garrett and Allegany counties, and in this article the causes of the present physiographic features are discussed (60). The other article deals with the Upper Devonian rocks (61).

The year 1882 was one of particular interest in the development of a correct knowledge of the structural geology of the county. Among the important publications which appeared during this year was a paper by Howard Grant Jones and one by Professor I. C. White. In Mr. Jones' paper a section west of Cumberland was given which was accompanied by a discussion of the correlation of the various rocks (72). Professor White later reviewed the work and rectified some of Mr. Jones' conclusions. Professor White's paper is the first publication showing conclusively the conformity and proper relations of the rock formations as found in the western part of Allegany county (76).

It was during this year also that report TT of the Second Geological Survey of Pennsylvania was published (75). This report is by Professor J. J. Stevenson and deals with the geology of Bedford and Fulton counties, which lie immediately north of Allegany county. In this report frequent reference is made to Allegany county, and much of the general discussion concerning the Pennsylvania counties is directly applicable to it.

In the Transactions of the American Institute of Mining Engineers, vol. xiv, 1886, R. S. Cook gives an account of the manufacture of fire-brick at Mt. Savage, which included a discussion of the occurrence and composition of the clay and a description of the methods of manufacture (90).

During the years 1883-4-5 considerable topographical mapping was done in Western Maryland and adjacent portions of West Virginia by the United States Geological Survey. The topographic party in the early part of the work was in charge of Mr. S. H. Bodfish. Later, Mr. Bodfish's health having failed, Mr. W. T. Griswold took charge of the party and remained in charge during the following two field seasons (86). During the year 1886 much of this work was examined, reviewed and prepared for publication by Mr. Merrill Hackett (87). Of the sheets surveyed at this time which include portions of Allegany county, only those covering the Piedmont and the Romney quadrangles have been published.

In the year 1897, topographic work was resumed in Allegany county by the United States Geological Survey in connection with the Maryland Geological Survey, since which time the survey of the county has been completed.

In volume 34 of the American Journal of Science, 1887, Professor J. J. Stevenson discusses the lower Carboniferous rocks of Pennsylvania, Maryland and the Virginias, and mentions various Allegany county localities (95).

In the same journal and in the same year, Professor I. C. White discusses the probable causes which have brought about the deposition of rounded boulders at high altitudes on the eastern side of the Alleghanies and makes particular mention of the vicinity of Cumberland (96).

In the 42d Annual Report of the New York State Museum, 1889, Professor John M. Clarke discusses "The Hercynian Question," in connection with which he gives important notes on some of the formations in the region about Cumberland (101).

During the year 1891, Bulletin No. 65 of the United States Geological Survey was published. This is by Professor I. C. White on

"The Stratigraphy of the Bituminous Coal Field of Pennsylvania, Ohio and West Virginia" (113). In this bulletin reference is made to the Coal Measures of Maryland, and the map which accompanies the bulletin includes the Cumberland-Georges Creek district.

It was in May of this year, 1891, that the students in the Geological Department of the Johns Hopkins University visited Allegany county under the direction of the late Professor George H. Williams for the purpose of studying Appalachian geology. The results of their study are given in volume xi, number 94, of the University Circulars for that year (114).

In 1893, in the Maryland World's Fair Book, entitled "Maryland. its Resources, Industries and Institutions," a general summary of the geology of the state was published by Professors George H. Williams and William B. Clark of the Johns Hopkins University, in which the geology of Western Maryland is discussed at considerable length (144). With this publication there is a geological map of the state in which the areal distribution of the various formations and the structure of the rocks of Allegany county are represented in much greater detail and accuracy than on any previous map.

In 1894, Mr. Howard Shriver, of Cumberland, published a short paper containing a catalogue of fossils found in the vicinity of Cumberland (150).

In the Fourteenth Annual Report of the United States Geological Survey, published during the same year, 1894, Joseph D. Weeks, under the title of "The Potomac and Roaring Creek Coal Fields," describes at some length the Cumberland-Georges Creek district, and gives a columnar section of the same (151).

During the years 1894 and 1895, H. O. Hofman and C. D. Demond describe, in the Transactions of the American Institute of Mining Engineers, extensive experiments which were carried on by them for the purpose of determining the refractiveness of fire-clays (148). Various experiments were made with the Mt. Savage fire-clay, and in the paper a number of analyses are given.

In 1896, the Piedmont Folio, No. 28 of the Geologic Atlas of the United States, was published by the United States Geological Survey

(159). The geological work was done by Messrs. N. H. Darton and Joseph Taff under the direction of Mr. Bailey Willis, and was begun in the autumn of 1894. The quadrangle covered by this folio includes a small area in the southwestern part of Allegany county, and the geology of the entire quadrangle is very similar to that of this county. Several of the formational names used in the folio have been adopted by the Maryland Geological Survey, and much of the discussion concerning the various geological features is directly applicable to Allegany county.

In the early part of the year 1896, the Maryland Geological Survey was organized, and at the opening of the field season began work in various parts of the state. Since then three volumes have been published by the survey under the direction of Professor William B. Clark, State Geologist. In volume I a general preliminary discussion of the various geological features of the state is given, including much new and valuable information concerning the stratigraphic, physiographic, economic and structural features of Allegany county.

Volume II includes a description of the various building stones and of the geologic maps of the state, with particular mention of Allegany county.

Volume III treats especially of the highways of the state, their present conditions and the material at hand in each of the counties for road-construction.

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STRATIGRAPHY AND AREAL DISTRIBUTION.

With the exception of some scattering Pleistocene deposits, all of the geological formations exposed in Allegany county are of Paleozoic age. The Pleistocene deposits are too poorly defined to receive satisfactory mapping, but the areal distribution of the Paleozoic formations is indicated on the geological map in the Physical Atlas accompanying this report, while their lithological features are shown on the columnar sections.

The stratigraphic relations of the several geological formations, all of which are herein described, are shown in the following table:

TABLE OF ALLEGANY COUNTY FORMATIONS.

Cenozoic.

Pleistocene.....Alluvial, etc.

Paleozoic.

Permian.....Dunkard.

Carboniferous.....Monongahela,
Conemaugh,
Allegheny,
Pottsville,
Mauch Chunk,
Greenbrier,
Pocono.Devonian.....Hampshire,
Jennings,
Romney,
Oriskany,
Helderberg.Silurian.....Salina,
Niagara,
Clinton,
Tuscarora,
Juniata.

Pleistocene
Dunkard
Monongahela
Conemaugh
Allegheny
Pottsville
Mauch Chunk
Greenbrier
Pocono
Hampshire
Jennings
Romney
Oriskany
Helderberg
Salina
Niagara
Clinton
Tuscarora
Juniata

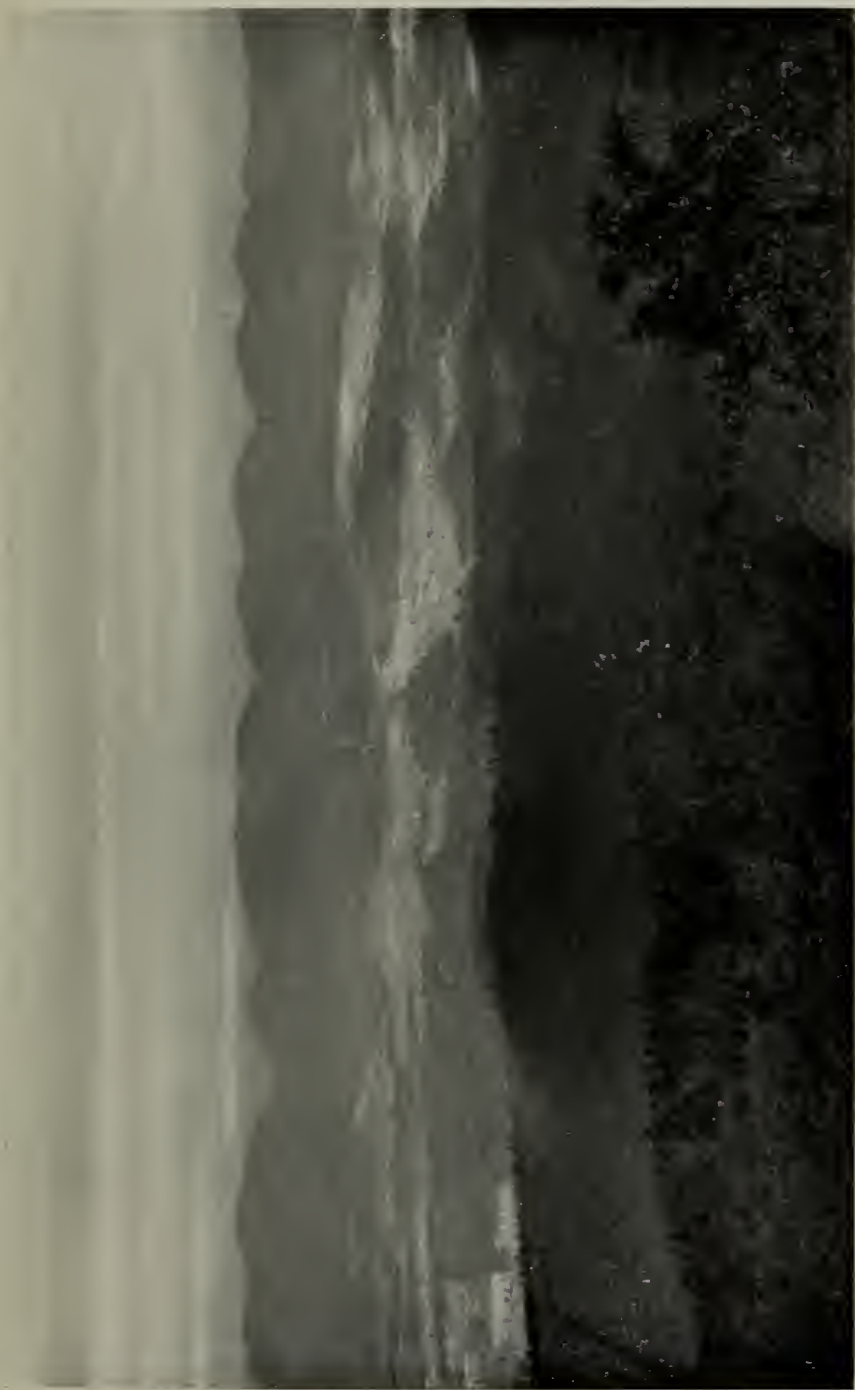
FIG. 4.

THE SILURIAN.

THE JUNIATA FORMATION.

The Juniata formation, known farther north as the Lower or Red Medina or Levant Red Sandstone, (IV b) receives its name from the Juniata river, Pennsylvania, along which it is typically developed. It includes the oldest rocks that appear at the surface in Allegany county and outcrops in only one locality. This outcrop is in the gorge just northwest of Cumberland where Wills Creek cuts through Wills Mountain.

The formation is made up of dull red sandstones and shales interbedded without any regularity of succession. The sandstones are hard, fine-grained, quartzitic near the top, cross-bedded and micaceous. Some of the beds exposed are more than one foot in thickness, but most of them are less than six inches. A few of the beds contain small rounded or flattened pellets of brittle yellowish-green



VIEW FROM DANS ROCK, LOOKING ACROSS THE POTOMAC VALLEY.

or reddish clay, the largest of which are usually less than one-half inch in diameter.

The shale beds vary from less than one inch to six feet or more in thickness. In general, they are considerably thicker than the sandstones, and the total thickness of shale in the exposure is much greater than the total thickness of sandstone. The shales, like the sandstones, are almost always distinctly micaceous and weather readily.

The depth to which Wills Creek has cut into the formation is 530 feet. However, 140 feet of this, computed according to the horizontal distance and supposed average dip, is concealed by the heavy talus derived from the overlying Tuscarora quartzite. Along the Baltimore and Ohio Railroad on the north side of Wills Creek the upper 370 feet is well shown, there being in all of this not more than twenty feet hidden. Here all of the remainder of the Juniata is concealed, but 140 feet below, on the opposite side of the creek, along the Cumberland and Pennsylvania Railroad, an additional exposure of thirty feet may be seen. With the exception of the 140 feet concealed, the measurements were all made with a steel tape.

Notwithstanding the good exposure of much of the formation, the various strata of shales and sandstones are more or less inclined to grade into each other, so that no satisfactory detailed section can be given. The top of the formation is considered as beginning with the highest distinct red shale bed, which is six inches thick where best shown. This may be seen in the small excavation at the spring on the north side of Wills Creek near the east end of the Narrows, a few feet above the Baltimore and Ohio Railroad track. Here the red shale bands quickly become of little importance, and the whiteness of the sandstone gradually but rapidly increases, the Juniata formation thus being separated from the Tuscarora by a transition zone of only a few feet in thickness.¹

THE TUSCARORA FORMATION.

The Tuscarora formation, perhaps nearly identical with the White Medina of the Pennsylvania and New York surveys, receives its

¹ For a discussion of contacts and transition zones, see Lesley, J. P., *A Summary Description of the Geology of Pennsylvania*, in three volumes. Vol. i, pp. 627 to 629, Harrisburg, 1892.

name from Tuscarora Mountain, Pennsylvania, where the formation is most typically developed. It is brought to the surface in five places in the county, viz., in Wills Mountain, where, lying conformably upon the Juniata, it gives rise to the higher portions of that mountain; in Evitts Mountain and in Tussey Mountain, of which it makes up almost the entire exposed surfaces; and in two small areas along the Baltimore and Ohio Railroad near Potomac Station, southeast of the southern end of Wills Mountain. The smaller of these last areas has been excavated about twenty feet in order to give a suitable grade for the railroad track. The larger area has a perpendicular exposure of more than one hundred feet above the railroad and extends to the southwest as a well-marked low ridge for a distance of nearly five hundred yards.

The formation is made up of snow-white to light gray quartzite, frequently cross-bedded and consisting usually of medium-coarse quartz grains in a very hard siliceous matrix. In some of the beds scattering quartz pebbles are found, but these are never abundant, and usually are not larger than wheat grains. Yellowish-green, hard clay pebbles of various sizes are sometimes found, but they are not common.

With the exception of casts of *Arthropycus harlani*, no forms of positive organic origin have been found in the Tuscarora of this county. Even *Arthropycus harlani* is not abundant in any of the Allegany county exposures, although the faces of some of the upper beds along Wills Creek in the Narrows are pretty well covered by the casts. Casts of *Arthropycus* are also shown, and possibly to a better advantage in the outcrops along the Baltimore and Ohio Railroad near Potomac Station. This plant form was found in greater abundance in the upper beds, the lower beds apparently being nearly destitute of them.

In general, the rocks are highly indurated and massive, and do not weather readily. In the Narrows and in Rocky Gap on Evitts Mountain, heavy talus slopes conceal the lower faces of the cliffs, while the overhanging walls of white rock give to these gorges a very rugged appearance. To some extent the same is true of the gap in Tusseys

Mountain, but this gap is so near the point where the mountain pitches beneath the surface that the walls of the gorge are very low.

The total thickness of the formation is shown only in the Wills Creek gorge in Wills Mountain. Here the thickness is 287 feet, a good measurement having been obtained by means of a line dropped from the top of the Narrows to the Tuscarora-Juniata contact at a point near the Baltimore and Ohio Railroad yard limits.

THE CLINTON FORMATION.

The Clinton formation is identical with the Clinton rocks of the New York section, the name being first used by the New York survey on account of the excellent development of the rocks in that state in the vicinity of Clinton. This formation lies conformably upon the Tuscarora quartzite and immediately surrounds the areas covered by the Tuscarora formation.

The largest area flanks Wills Mountain on either side, and continuing south-southeast beyond Cresap, encloses the smaller Tuscarora areas on the Potomac where that river makes a strong bend to the southeast. Another area lies to the northeast of Cumberland where, coming in from Pennsylvania, it flanks the southern end of Evitts Mountain. A third area lies further east and holds the same relation to Tussey Mountain northwest of Flintstone that the second area holds to Evitts Mountain.

The Clinton is composed essentially of thin reddish and greenish-yellow shales, while sandstone beds, some of which are of considerable thickness, occur in it, and a few thin beds of limestone appear in the upper part. Two important beds of iron ore are also found in it. In the lower part, where light colored shales predominate, the several transition sandstones present are more or less quartzitic, but are of no very great thickness. These lower sandstones are best seen on the south side of Wills Creek at the east end of the Narrows.

Near the top of the formation there is a light gray massive sandstone generally about ten feet thick. This is well shown along the Baltimore and Ohio Railroad about forty rods west of Brady, where the thickness is a little less than ten feet, and where the sandstone is

overlain by a six-inch bed of hematitic iron ore, known as the upper Clinton iron ore. A sandstone which apparently corresponds to the above-mentioned sandstone was seen on the National Road northeast of Cumberland, a little west of the Sixmile House, one hundred yards west of the junction of the Johnston Road with the National Road.

The limestones of the formation are seldom six inches in thickness, and are much inclined to occur in layers about two inches thick, interbedded with shale bands of similar thickness. The limestones are almost always highly fossiliferous.

The shales occupy most of the lower part of the formation, besides a considerable space in the middle and upper portions. These also frequently contain fossils. In color, they are usually a yellowish green or olive where freshly broken, but the flat exposed surfaces frequently have a marked scarlet color. Near the bottom of the formation the shales have more of a dull grayish brown appearance and are less fossiliferous.

The lower Clinton iron ore includes two beds separated, where best seen, by six feet of greenish calcareous shale. The thickness of the lower bed averages about four and one-half feet and is 160 feet above the bottom of the formation, as shown on the Baltimore and Ohio Railroad southeast of Cresap between the two small Tuscarora exposures. The other bed, six feet higher, not fully exposed, shows a thickness of eight feet where observed southeast of Cresap, and is ten feet thick at Cumberland, north of the cement mill, where it is cut through by Wills Creek. All of the iron ore beds are fossiliferous, the upper bed of the lower ore being sometimes excessively filled with the various Clinton fossils.

The following partial section was measured on the Baltimore and Ohio Railroad southeast of Cresap:

	Feet.
Red iron ore band. (Not exposed to the top).....	8
Calcareous greenish shale	6
Red iron ore band	4½
Fine brownish red and green arenaceous shale with several thin but compact sandstones or quartzites near the bottom.	160
Clinton-Tuscarora contact	—
Total amount exposed	178½

Along the south side of Wills Creek, at the east end of the Narrows, the full thickness of the Clinton shows the following section:

	Feet.
Shales and fossiliferous limestone, mostly concealed.....	33
Reddish shale with a few thin limestone bands (more or less concealed and perhaps containing the upper Clinton iron ore near the top)	29
Fossiliferous gray shale and blue limestone, with five and one-half feet of shaly sandstone near the bottom.....	28
Concealed	57
Reddish olive fossiliferous shale	24
Concealed	238
Fossiliferous iron ore (Lower Clinton ore)	10
Rusty olive shale	17
Fossiliferous olive-colored shale	85
Rusty shale at top. Uneven bands of gray sandstone at bottom interstratified with olive shales	36
Olive-colored shales with thin beds of brownish gray quartzite,	27
Clinton-Tuscarora contact	—
Total thickness of Clinton	584

THE NIAGARA FORMATION.

The Niagara formation, the name of which is derived from Niagara Falls, New York, where excellent exposures of these rocks have given opportunity for their careful study, lies conformably on the Clinton and, surrounding the outcrops of that formation, occupies areas closely related to them in size, in shape, and in geographical distribution.

The westernmost area lies as a narrow belt around the base of Wills Mountain and extends southward to the Potomac river near Potomac Station. The second area lies as a sharp loop around the southern end of Evitts Mountain with a narrow projection southward along its pitching anticline, while the third area is similarly situated about Tussey Mountain.

In Allegany county the Niagara is pretty much concealed, the areas about Evitts and Tussey mountains affording no satisfactory exposures, while the Wills Mountain area shows only one complete section. This is on the Potomac river just west of the cement-mill near Potomac Station. The formation is made up almost wholly of thin limestones with shale partings. The shale partings become of

considerable thickness in the upper portions where they predominate over the limestones. In the lower portions the limestones predominate and the partings are very thin. A few thin sandstones are found near the top interbedded with the shales and limestones.

The thickness of the formation as measured along the south side of Wills Creek in Cumberland is 260 feet. The rocks are, however, mostly concealed and the upper and lower limits of the formation cannot be accurately determined. In the Potomac Station section the formation was found to be 317 feet thick, but owing to the considerable folding here the measurement may not be exact. The true thickness certainly approximates 300 feet, and this may with propriety be considered as the thickness for the county. The section as measured by R. B. Rowe along the Baltimore and Ohio Railroad near Potomac Station is as follows:

	Feet.
Niagara-Salina contact	
Black shales with layers of sandstone and an occasional layer of limestone	22
Mostly dark blue limestone with shale partings. Very fossil- iferous at top, less fossiliferous near the bottom. Some folding, but the measurement is believed to be fairly accurate	225
Dark blue limestone with thin shale partings. So much folded that the thickness can be only estimated	70
Niagara-Clinton contact	—
Total thickness of formation	317

THE SALINA FORMATION.

The Salina formation receives its name from Salina, New York, where it is typically developed. The rocks of this formation follow those of the Niagara conformity and are distributed about Wills Mountain, Evitts Mountain and Tussey Mountain in much the same manner as the two preceding formations. Along the eastern base of Wills Mountain the Salina has been cut through by the meanderings of the Potomac, thus throwing portions of the outcrop on the West Virginia side.

The formation is composed of sandstones, shales and limestones. The sandstones predominate near the bottom and the limestones in the upper portions, while the shales are rather abundant throughout



FIG. 1.—CHARACTERISTIC EXPOSURE OF CLINTON SANDSTONE.



FIG. 2.—HARD STRATA IN HELDERBERG FORMATION, DEVIL'S BACKBONE.

GEOLOGICAL SECTIONS IN ALLEGANY COUNTY.

the formation. Cement rock of importance is found in the lower part. The location of the four cement beds of commercial value is given in the section below.

The rocks of this formation are not well exposed except along Wills Creek in Cumberland, along the Potomac river near Potomac Station, and along Flintstone Creek at Flintstone. Much of the Wills Creek section can be made out only with difficulty, but the Potomac section is well shown. West of the cement mill in Cumberland the red sandstone beds at the bottom of the formation can be readily seen, as can also considerable portions of the shales and limestones, including the cement series. Immediately north of Flintstone, along Flintstone Creek, various lower beds are fairly well exposed. Around Evitts Mountain the rocks are almost wholly concealed. The Potomac section, the best exposed section of Salina in the county, measures as follows:¹

	Feet.
Salina-Helderberg contact	
Gray papery shales, dark drab magnesian limestone, dark blue limestone and yellowish and green sandstones in various relations to each other and all thin bedded. Fossils (Ostracods) are present, especially near the bottom.....	450
"Fourth" cement rock. A twelve-inch band of limestone is found about five feet from the bottom	17
Bluish gray shaly rock with some thin arenaceous and calcareous beds	19½
"Third" cement rock	12½
Light greenish, fossiliferous shales with some calcareous and arenaceous layers	54
"Second" cement rock	15
Massive fossiliferous limestones alternating with thin cement layers	15
"First" cement rock	6
Bluish green shale with three and one-half feet of darker shale at the top. Fossiliferous	15
Greenish gray sandstone	3½
Light brown disintegrated rock, probably limestone originally	8
Greenish gray massive sandstone	7
Bright yellow sandstone	½
Thinly bedded greenish gray sandstone	2½
Dark, fine-grained shale	13½
Salina-Niagara contact	
Total thickness of Salina	639

¹ Section of R. B. Rowe.

THE DEVONIAN.

THE HELDERBERG FORMATION.

The Helderberg formation, so called from its typical locality, the Helderberg Mountains of New York, is considered by some geologists as the lowest Devonian formation, while others regard it as the highest Silurian formation. It follows the Salina of the Silurian with perfect conformity and, like all of the preceding formations, is exposed only in the central and west-central portions of the county. The easternmost and largest area, shaped like a much constricted letter W, lies to the east, west and south of Tussey Mountain, and by its prominent double bifurcation makes up a large part of Warrior Mountain and Martin Mountain. On the state line east of Tussey Mountain the Helderberg belt is less than one-half mile wide, while the width of the corresponding outcrop on the western side is considerably greater. Southward, owing to the pitching of the Tussey Mountain anticline, these bands gradually approach each other until, at a point near Rush, the two coalesce. Within less than one mile southward the area again becomes bifurcated, but this time, owing to the synclinal nature of the fold, the projecting parts are separated by the Oriskany formation, which immediately follows the Helderberg. Of the two southern Helderberg projections, the one furthest east is the more extensive, and includes within it Flakes Knob, the highest point in the county east of the Alleghany Front. This part of the area narrows southward, but caps Warrior Mountain to within almost a mile of where the mountain ceases to be a distinct topographic feature. The projection lying further west is much narrower than the one to the east, but continues almost as far south and acts as a capping for Collier Mountain.

The next area of Helderberg lies further west and flanks the outcrop of Salina around Evitts Mountain in much the same way that the first area does the Salina around Tussey Mountain. The bifurcation at the north caused by the Evitts Mountain anticline is quite like that produced by the Tussey Mountain anticline. The formation continues southward in one long, continually narrowing band to within one and one-half miles of the Potomac, where the Helderberg

ending in a sharp point passes beneath the Oriskany to appear again at the roadside by the canal, where the Potomac has cut entirely through the overlying Oriskany and into the Helderberg for a distance of fully a hundred feet. The eastern part of this area forms much of the crest and western slope of Nicholas Mountain, while the contact line along the western side is clearly marked by a row of hills extending from the state line southward. This row of hills reaches almost as far south as does the Helderberg outcrop, but finally coalesces with Nicholas Mountain.

East of Wills Mountain a belt of Helderberg averaging less than one-half mile in width comes into the county from the north, and extending southward along the western slope of Shriver Ridge, passes through the western part of Cumberland and across the Potomac into West Virginia. The Potomac in its very perceptible eastward bend nearly three miles above Cumberland, and again in the more prominent eastward bend about six miles above Cumberland, has carved out two small portions of this belt from the West Virginia area. These patches are mostly concealed, but their contact with the Salina is fairly well shown. Northward the Helderberg-Salina contact is largely concealed, but the limestone quarries which occur in the lower part of the Helderberg along the western base of Shriver Ridge afford a convenient means of judging the approximate western outcrop of the Helderberg. Shriver Ridge marks the eastern limit, as the contact lies on its western slope a short distance below the top.

West of Wills Mountain there is a band of Helderberg corresponding in position to the eastern belt, but by reason of the perpendicular attitude of the strata, this belt is considerably narrower than the one on the eastern side. Following closely the general direction of Wills Mountain, it crosses the Potomac river at Potomac Station. Along the belt north of the National Road the Helderberg-Salina contact is usually not well shown, but the Helderberg-Oriskany contact is prominent, the latter being represented by the steep ridges to the north and south of Corriganville. South of the National Road neither contact is well shown, although slight topographic features usually indicate their positions with reasonable accuracy.

Another Helderberg area of considerable extent is exposed south of Rawlings. This forms the body of the steep isolated ridge known as Fort Hill, which extends southward along the Potomac for a distance of about four miles.

In addition to the above-mentioned areas, two very slight exposures may be seen along the West Virginia Central Railroad on the north and south sides of Monster Rock near Keyser, West Virginia. They are of little importance except in so far as they are of value in helping to work out the structure in that part of the county.

Lithologically, the Helderberg is pre-eminently a limestone formation. Argillaceous materials occur as impurities in some of the beds, but these are not important, and sandstones are almost wholly lacking. Thin bands of chert, which are white or yellowish-white in color, occur sparingly throughout the upper part of the formation. Most of the limestone in the upper part is heavily bedded, and much of it is highly fossiliferous. The lower part of the Helderberg is a dark blue thin-bedded limestone which in breaking gives a decided ring. This corresponds to the Tentaculite limestone of New York, which in Maryland is over 400 feet thick. In the field the contact between the Salina and the Tentaculite limestone is very marked because of the different weathering qualities of the two rocks. The Salina rock weathers into soil very completely, while the Tentaculite limestone leaves innumerable small, thin, dark blue slabs upon the surface.

In Western Maryland the Tentaculite limestone is mapped as a part of the Helderberg formation. This is done because the lithological break between it and the Salina is very marked and can be followed in the field, as shown above, while there is no lithological break between the Tentaculite and Lower Pentamerus subformations, and the division for mapping purposes cannot be made here. Professor James Hall of the New York survey always insisted that the Tentaculite should be considered as a portion of the Helderberg, while Professor James D. Dana considered it as a portion of the Waterlime (Salina) formation. Since Professor Hall's death, even the geologists of the New York survey have been inclined towards Dana's view. The Tentaculite limestone of Western Maryland has

not only a greater thickness but also a more abundant fauna than that of the New York region.

This fauna, as will be shown in the more complete systematic reports, belongs to the Silurian and Devonian. It is too premature, at least, to assign all of the Helderberg of Maryland to either the Devonian or Silurian systems.

The thickness of the formation is nearly eight hundred feet. The two partial sections given below are believed to represent the full thickness as well as a duplication of some of the middle beds as indicated. The Potomac section extends from the bottom of the formation to and includes a few inches of the coralline ledge. The thirty-six foot massive *Stromatopora* bed of the Devil's Backbone section is believed to come in immediately above this, the other beds of the section continuing upward in the order named to the top of the formation.

The Devil's Backbone section, measured along the Huntingdon and Broadtop Railroad east of Wills Creek is as follows:

	Feet.
Helderberg-Oriskany contact	
Concealed	42
Light gray fossiliferous limestone with numerous layers, a very light-colored chert	22
Light gray massive fossiliferous limestone. Breaks into rec- tangular blocks	16
Shaly limestone	1½
Bluish gray limestone, breaking into shaly fragments. Weathering indicates much argillaceous material.....	18
Massive <i>Stromatopora</i> beds	36
Shaly limestone, somewhat nodular	10
Light gray massive limestone with upper part containing layers of light-colored chert	45
Thinly bedded limestone, the weathered surface covered with small bryozoans	16
Dark blue massive limestone, very hard and difficult to break...Upper part filled with <i>Pentamerus galeatus</i>	36
Fine shaly fossiliferous limestone	16
Massive dark blue fossiliferous limestone	40
Slightly argillaceous, thinly bedded, fossiliferous limestone.	14
Gray arenaceous fossiliferous limestone with layers of cherty material	16
Concealed to bottom of formation	—
Total thickness of exposure at this place.....	328½

The measurements made at Potomac Station are as follows:

	Feet.
Upper beds concealed. Very massive light gray limestone with a few feet of nodular limestone near the top.	
Coralline layer near the top	95
Mostly concealed, but sufficiently exposed to show that the beds are generally made up of thin grayish limestones.	
Some massive beds are present	240
Generally thin-bedded, dark blue limestone, but with some heavy beds. Fossiliferous	145
Thinly bedded, dark blue fossiliferous limestones with occasional papery shales	92
Helderberg-Salina contact	—
Total thickness of exposed Helderberg	575

THE ORISKANY FORMATION.

The Oriskany formation receives its name from Oriskany Falls, New York, at which place it is well shown. In middle and western Allegany county the Oriskany, although thin compared with most of the other Paleozoic formations, on account of its zigzag course and usually more or less inclined position, covers a not insignificant part of the surface. To speak definitely, the Oriskany-Romney contact is more than one hundred miles in length, being considerably greater than that of any other contact line in the county. Coming in across the Maryland-Pennsylvania state line near Flintstone and going southward, the Oriskany constitutes the eastern slope of Warrior Mountain. Returning northward near Big Spring Run, it forms much of the western slope of Warrior Mountain. It enters quite largely into the structure of Martin Mountain and completely covers the central and southern portions of Collier Mountain, including the two projections near the Potomac. It also constitutes the western slope of the northern part of Martin Mountain continuing beyond the state line. Branching south of the state line, one part returns southward and forms much of the eastern slope of Nicholas Mountain. It continues to the Potomac, but turning northward once more it helps to form the line of hills that flank Nicholas Mountain on the west, then again passes beyond the state line.

A little further to the west a narrow strip along Shriver Ridge cuts across the county in a northeast-southwest direction through

Cumberland. West of Wills Mountain a still narrower strip comes in from the north, runs approximately parallel with considerable portions of Wills Creek and Braddock Run, then bending to the east takes a more nearly north and south direction and passes across the Potomac near Potomac Station. Another area extends from Rawlings, southwestward through Keyser, West Virginia. Geologically, the outcrop is not discontinuous between these points, but a small part of it has been cut off from the county by a bend in the Potomac river north of Monster Rock. A very small area is also found near the bend of the river east of Monster Rock, a short distance from Keyser, West Virginia, but this is greatly obscured by the comparatively recent river deposits.

In addition to the above-mentioned areas, there are two others well shown east and northeast of Oldtown, besides one or more obscure patches in the bed of a ravine west of Corriganville. The smaller of the Oldtown areas covers less than half a square mile and outcrops immediately north of the Potomac and just west of the mouth of the South Branch. The other area forms Stratford Ridge, lying just west of the lower course of Town Creek. These last two areas are minor extensions or spurs of the much higher ridge south of the Potomac in West Virginia.

The Oriskany formation in Allegany county consists of two well-marked lithological divisions which grade into each other. The lower part, resting conformably upon the Helderberg, is a blue-black chert in nodules and layers, separated by thin beds of dark gray arenaceous shale. This is the "chert lintel" of the Piedmont folio.¹ The upper part of the formation is a greenish gray, bluish gray, brownish gray or white sandstone, which is often calcareous.

The chert in an unweathered condition is in hard, deep blue-black masses and shows a great tendency to break into small-sized nodular or angular blocks with smooth conchoidal fractures. The unweathered surfaces have at times a pearly white appearance and the weathered specimens are almost invariably light colored. Specimens in which weathering has been carried on to an extreme degree usually

¹ Geologic Atlas of U. S. Piedmont Folio, No. 28.

show a yellowish brown color and are more or less arenaceous and spongy. The Helderberg-Oriskany contact line can often be easily followed by these chert fragments even if all other traces of the contact are gone. So numerous are the fragments in many places that in some well-cultivated fields they lie sufficiently close together to almost completely hide the surface of the ground. This is particularly noticeable in some of the fields near the tops of Warrior Mountain, Martin Mountain and Nicholas Mountain. In the vicinity of Flakes Knob on Warrior Mountain the chert beds have been worn entirely through, and on the top of this highest point the underlying limestone is exposed. Surrounding this high knoll is a heavy talus of the chert blocks. Near the top of Martin Mountain on the National Road a good exposure shows the chert weathered to spongy blocks sufficiently soft to be easily cut with a knife. The same thing may be observed in other places, although usually it is not so well shown. West of Wills Mountain on the Georges Creek and Cumberland Railroad and on the Eckhart branch of the Cumberland and Pennsylvania Railroad the same alteration has taken place, but some of the beds here show a more or less bright-colored banded structure. This is apparently due to a rearrangement of the ferruginous contents, thus leaving some portions with a peculiar bluish gray color, while other portions show yellowish, brownish or reddish parallel bands. No outcrop in the northern part of the county shows the full thickness of the chert, but the outcrop at the Devil's Backbone compared with outcrops near Keyser, West Virginia, and near North Branch seems to indicate pretty conclusively that these beds thicken rapidly southward.

The upper portion, or sandstone member, of the Oriskany when wholly unweathered is usually hard and compact, and is at times rather inclined to resemble a very arenaceous limestone. The texture is sometimes fine, but the rock is more often coarse-grained, and in the upper part of the formation one or more bands of conglomerate are always present. In the exposures near Keyser, West Virginia, the lower part of the formation is shaly, while the middle and upper portions apparently contain a greater percentage of coarse material



FIG. 1.—FOLD IN ORISKANY SANDSTONE, NEAR MOUTH OF SOUTH BRANCH OF THE POTOMAC.



FIG. 2.—ORISKANY EXPOSURE, MONSTER ROCK, NEAR KEYSER, W. VA.

than elsewhere. Generally fossils are extremely abundant, occurring in irregular bands varying in thickness from one or two inches to several feet. The sandstone easily losing its calcareous cement, weathers readily to a very friable, dirty-buff, porous rock, in which condition large blocks can be easily shattered by a single blow of the hammer. In many places protected from denudation, the rock has completely disintegrated, leaving beds of dirty brownish-yellow sand. In this loose sand, under favorable conditions, well-preserved fossils may be procured. Pockets are frequently found in the less weathered rocks in which fossils free from the matrix are also beautifully preserved. It is to these pockets that many collectors owe their finest cabinet specimens.

Excellent exposures of the Oriskany are frequent, but the full thickness is not often shown. The thickness as measured on the south side of Monster Rock near Keyser, West Virginia, is three hundred feet, and at 21st Bridge, three hundred and forty feet; on the Williams Road, two and one-half miles east of Cumberland, only one hundred and fifty-five feet are exposed. On the eastern slope of Warrior Mountain no good measurement could be obtained, but apparently the thickness there where best shown is less than at Cumberland. The following section was obtained along the West Virginia Central Railroad at the base of Monster Rock, opposite Keyser, West Virginia:

	Feet.
Oriskany-Romney contact	
Fine-grained fossiliferous conglomerate	12
Coarse sandstone with few fossils	6
Fine-grained fossiliferous conglomerate	4
Coarse but slightly shaly sandstone	4½
Coarse-grained fossiliferous sandstone	8
Fossiliferous conglomerate	1
Coarse fossiliferous sandstone	3½
Very fossiliferous coarse conglomerate	½
Coarse-grained fossiliferous sandstone	12
Fossiliferous sandstone, mostly coarse-grained	156
Coarse shaly, almost non-fossiliferous, sandstone	25½
Black nodular chert	67
Concealed	
Total thickness measured	300

On the Williams Road, two and one-half miles east of Cumberland, the Oriskany section is as follows:

	Feet.
Oriskany-Romney contact	
Coarse sandstone, almost black and non-fossiliferous.....	2
Much-decomposed yellowish sandstone with many fossils...	16
Concealed	6
Slightly fossiliferous conglomerate, the individual particles being of characteristic wheat-grain size	4
Concealed	7½
Very fossiliferous conglomerate	2½
Concealed	2
Blue calcareous fossiliferous sandstone	1½
Coarse, much-weathered, fossiliferous sandstone	2½
Concealed	14½
Very coarse fossiliferous brown sandstone	3
Fossiliferous conglomerate much like the wheat-grain con- glomerate above	1
Brown fossiliferous sandstone	29
Concealed	42
Sandstone and concealed, mostly concealed	30
Concealed	
Total thickness measured	156

The Oriskany-Helderberg contact is not shown here, and there is at least 90 feet of chert still to add to the thickness.

In the well-weathered Williams Road exposure the conglomerate bands are easily distinguished from the intervening finer material, but in the Monster Rock section, where the present face of the rock has been exposed only a few years, the lines of separation are much less clearly marked. This indistinctness, which is one of appearance rather than reality, is largely due to the bluish-gray color of many of the pebbles, as well as to the calcareous cement which is present in the conglomerate bands and in the finer sandy portions.

In general, the individual pebbles of the conglomerate are fairly well rounded, usually of approximate wheat-grain size, and seldom larger than peas. In many places the rocks are densely crowded with fossils. This is particularly true of the formation in the vicinity of Cumberland, the locality from which Professor Hall has described so many forms. Frequently the conglomerate bands partake of this fossiliferous nature, but the fossils are usually more abundant in the

finer portions. In Warrior Mountain the exposures are usually not good, and where exposed the fossils are less abundant, the sandstone there being less calcareous and highly compact.

The Oriskany sandstone, although playing an important part in the composition of the mountains of Allegany county, owes much of its prestige, especially in the more calcareous areas, to the protection of the less easily disintegrating Oriskany chert beds.

THE ROMNEY FORMATION.

The Romney formation, corresponding in the main with the Marcellus and Hamilton formations further north, takes its name from Romney, West Virginia, where it is extensively developed. The passage from the Oriskany to the Romney is particularly abrupt, a distinct lithologic difference existing within a space of two inches. This contact is admirably shown on the Williams Road near the church two and one-half miles east of Cumberland, as well as on the north and south sides of Monster Rock along the West Virginia Central Railroad. It is also seen to good advantage on the Baltimore and Ohio Railroad one-fourth of a mile south of Rawlings, and on the same railroad about two miles northeast of Keyser, West Virginia. In various places along the east side of Warrior Mountain the contact is disclosed, but the opportunities for studying it are not so good here as elsewhere.

Next to the Jennings the Romney is the most widely distributed formation in the county. The largest area lies along the Potomac river in the vicinity of Oldtown. It includes the valleys of Big Spring Run and Saw Mill Run and much of the lower course of Town Creek and sends a narrow belt northward along the eastern side of Warrior Mountain beyond the state line into Pennsylvania. Further west along either side of the southern end of Martin Mountain there are small, elongated Romney areas which coincide approximately with the narrow valleys of Collier Run and Martin Spring Run. In the Evitts Creek valley a belt of considerable width comes into the county from Pennsylvania and passing southward is divided by a large Jennings area, the two Romney bands thus formed passing along

down on the higher slopes of the valley and continuing southward help to cover the Maryland projection west of the southern end of Nicholas Mountain. At the foot of Alleghany Front another area is shown which, like several of the succeeding formations, stretches as a somewhat narrow belt entirely across the county. Near Rawlings a prominent offshoot projects from this belt across the Potomac into West Virginia. On the eastern side of Monster Rock a slight, synclinal fold has preserved a very small area, but this is almost wholly concealed.

In general the formation is an argillaceous fissile shale, intensely black and papery near the base, but more often of a drab color above, the upper part weathering into fine angular fragments. Owing to a lack of hard material, the formation is prominent in the valleys, where it forms low ridges or rounded hills.

The sandstones and sandy shales of the formation are comparatively unimportant. However, on the Williams Road two and one-half miles east of Cumberland near the middle of the formation, there is a bed of brownish-gray sandstone weathering readily into irregular rhombs or lozenges, the whole being fifty feet thick. Thin irregular streaks of sandy shale are shown at various horizons below the middle of the formation on the Baltimore and Ohio Railroad in the cut immediately north of 21st Bridge on the West Virginia Central Railroad. Northeast of Cumberland, between Shriver Ridge and Evitts Creek, there is a series of well-defined parallel ridges which apparently owe their preservation largely to shaly sandstone. In the Town Creek valley east and west of Saw Mill Run the various Romney ridges there appear to be quite free from sandstone. Most of these ridges show to good advantage the characteristic weathering of the upper shales. On the ridge west of Saw Mill Run two miles northwest of Oldtown, the exposed shales have completely broken up into fine irregularly angular, almost cubical blocks of various sizes usually considerably smaller than walnuts. These small fragments at this place are in such extreme abundance that they lie upon the surface of the ridge just within the angle of rest and in beds so deep and so frequently subject to gravitational movement that vegetation is limited almost wholly to stunted pines.

The intensely black shales at the bottom are very carbonaceous but do not contain coal seams. However, along Collier Run, where the lower beds can be easily reached, as well as along the road near the Warm Spring iron bridge one mile south of Flintstone, the shales have been fruitlessly worked with the idea that they might prove to be coal-bearing.

About one hundred and fifty feet from the bottom of the formation there are several bluish-gray fossiliferous limestone bands. These are apparently never absent, although in the well-exposed Williams Road section none of them can be seen. This is perhaps due to the effect of weathering, as certain evidences indicate their probable presence. These bands are individually rarely three feet, usually less than one foot thick, but the total thickness in the best exposed sections is more than twenty feet. They are shown to good advantage in the West Virginia Central Railroad cut at 21st Bridge, one mile northeast of Keyser, West Virginia. They are found less clearly shown on the county road along the lower course of Martin Spring Branch east of the Oriskany fork at the south end of Martin Mountain, where a little of the limestone has been burned for fertilizing purposes. In various other places more or less limestone is shown but the exposures are not of sufficient importance to demand special mention.

One of the upper beds, about six inches thick, known as the Nautilus Ledge, shows great persistence, having been found at several widely separated localities. Another bed, usually from two to two and one-half feet thick, is honeycombed with concretionary nodules. These nodules, which are from one-half inch to four inches in diameter and generally more or less ferruginous, gradually weather free from their matrix and may be found in many localities scattered about in considerable numbers over the ground.

Iron-ore pockets have been found in various localities along the eastern base of Warrior Mountain near the bottom of the Romney formation. Iron ore may also be seen between and slightly to the west of the two Oriskany outcrops northeast of Oldtown. There are indications of the ore elsewhere, but in no case can the exact horizon

be definitely located, nor can the full thickness at any place be learned. It is evidently very near or at the bottom of the Romney, and the theory has been advanced¹ that its presence indicated a possible local unconformity between the Oriskany and the Romney formations.

THE JENNINGS FORMATION.

The Jennings formation, closely related to the Chemung and Portage of the Pennsylvania and the New York Geological Surveys, is so called from its typical development in Jennings Gap and along Jennings Branch, Virginia. It follows the Romney with perfect conformity and has a considerably greater areal distribution than any other formation in the county. It occurs in four large areas. Farthest east is the much dissected strip east of Town Hill running from the state line southward beyond the Potomac river. A long irregularly shaped area west of Green Ridge extends entirely across the county; it is scarcely more than a mile in width in the southern part, but in the northern part, on the state line, it is about seven miles wide. Polish Mountain lies in the northwestern part of this area. In the lower part of the Evitts Creek valley and in the big bend of the Potomac immediately south, there are two good-sized areas which for our purpose here may be considered as one. There is also a strip nearly a mile wide and about twenty-five miles long stretching northeast-southwest across the widest part of the county on the eastern slope of Alleghany Front.

The deposits of this formation are almost wholly arenaceous. In the lower and middle parts the thin layers of sandy shales and quartzose sandstones are interbedded with no regularity of sequence or of thickness. In the upper part heavy quartzitic sandstones predominate, but even here the sandy shales are in considerable abundance. In connection with the heavy quartzitic beds there are several more or less important beds of conglomerate, some of which are fossiliferous. Fossils also occur in the sandstones at various horizons, the fossiliferous beds being densely crowded, usually sharply defined

¹Darton, N. H. Notes on the Stratigraphy of a portion of Central Appalachian Virginia, Amer. Geol., vol. x, July, 1892, p. 16.

and seldom more than a few inches in thickness. The lower shales of the Jennings are thin and black, somewhat resembling those at the base of the Romney formation. The upper part of the Jennings is lithologically indefinite. The paleontological evidence indicates that the formation extends about six hundred and fifty feet above the heaviest conglomerate. This conglomerate is prominent in many parts of the county and from its situation so near the top of the formation can be used advantageously as a guide in tracing the upper contact. This conglomerate in Jennings Run is thirty-five feet thick, the lower six feet of which is flaggy and contains only scattered pebbles. The remainder is massive and is highly charged with flattened or rounded white quartz pebbles of various sizes up to one inch or more in diameter. This conglomerate is apparently continuous over the county. It is well marked by a line of hills along the eastern slope of Alleghany Front and near the southern end of this line of hills four and one-half feet of the bed is shown. Whether or not this represents the entire thickness at this point could not be learned. At various intermediate points the conglomerate does not show, but this is thought to be due not so much to its thinness as to more complete concealment. Remnants of the same conglomerate are seen along the top of Polish Mountain. It is not well shown on Green Ridge, although there is abundant evidence of its presence, but along the eastern flank of Town Hill it appears to be of considerable thickness. Along the Little Orleans-Oronoko Road near the western end of the big bend of the Potomac about three miles west of Little Orleans the abundance of loose conglomerate boulders indicates a considerable thickness there. The individual pebbles are quite large, equaling the largest found in Jennings Run. Above this big conglomerate, as well as below it, there are thinner conglomerates which, although they may be of very varying thickness, are nevertheless generally present. They are usually greatly iron-stained, but when not so they much resemble some of the Carboniferous conglomerates. However, to one accustomed to observing them, the more flattened nature of the pebbles and the very characteristically smooth fracture across both matrix and pebbles at once distinguish the Jennings from the Carboniferous conglomerates.

The thickness of the formation appears to vary within rather wide limits. Along Jennings Run it is thought to be between thirty-five hundred and four thousand feet, although no good measurement could be made. Along the Potomac near the mouth of Town Creek it is approximately five thousand feet.

THE HAMPSHIRE FORMATION.

The Hampshire formation, approximately equivalent to the Catskill of the North, receives its name from Hampshire county, West Virginia, where it is extensively developed. In Allegany county these rocks are exposed in three areas as follows: First, in the eastern part where Sideling Hill Creek and the Potomac river have carved out small portions of the wide belt which underlies Sideling Hill further east. Since these several small patches are closely related structurally, they may here be considered together as one area. Second, a belt nearly three miles wide which runs northeast-southwest across the county forming the base of Town Hill. Third, a strip averaging perhaps one-half a mile in width which lies along the eastern face of Alleghany Front and stretches entirely across the county. The patches included under the first area are largely concealed by their own detritus. The rocks in the second area are well exposed only along the Potomac river and in the gap of Fifteenmile Creek. In the western area the rocks are shown to good advantage along Jennings Run. They are shown to less advantage along Braddock Run, and in the Potomac gorge they are largely concealed.

In composition the Hampshire is an extensive monotonous series of cross-bedded, flaggy and massive sandstones and fine-grained very fissile sandy and argillaceous shales. The shales are usually bright red or brownish red, although some gray and green or even yellowish shales are seen. These latter colors occur more frequently near the top of the formation, and this is particularly noticeable just outside of the county immediately east of the mouth of Sideling Hill Creek. The sandstone beds near the bottom are heavy, being in several instances more than twenty feet in thickness. The shales and sandstones frequently merge gradually into each other, both laterally and

vertically, and are interbedded without any constant order of succession.

The thickness of the Hampshire along Jennings Run is nineteen hundred feet. Along the Potomac river in the Town Hill syncline a measurement of nineteen hundred twenty-five feet was obtained. The Jennings Run measurement is believed to be quite accurate and the measurement in the Town Hill syncline approximately so.

THE CARBONIFEROUS.

THE POCONO FORMATION.

The Pocono formation, named from Pocono Plateau, Pennsylvania, where it is well developed, is the basal member of the Carboniferous and lies conformably upon the Hampshire formation of the Devonian. Of these rocks there are only three narrow areas shown in the county. One occupies a position along the eastern slope of Alleghany Front, capping a line of knobs which extend across the county. The other two, separated by the Fifteenmile Creek gorge, form the crest of Town Hill.

Little study of the formation could be made on Town Hill, but it is known to consist largely of a very massive conglomerate in which the milky quartz pebbles are pretty well rounded. The size of the pebbles varies much, ranging up to three-fourths of an inch in diameter or even larger. In the western part of the county the lithological character of the formation is very different. The entire thickness is shown, although to poor advantage, on the Cumberland and Pennsylvania Railroad in the first tunnel east of Eckhart, where the thickness is two hundred and fifty-eight feet. In the Potomac gorge between Westernport and Keyser, West Virginia, there is an exposure of only thirty feet, but this may represent the entire thickness of the formation at that point. It has been so considered in the Piedmont folio.¹

In the Cumberland and Pennsylvania Railroad section the bottom of the formation extends sixty feet east of the east end of the tunnel,

¹Geologic Atlas of the United States, Piedmont Folio, Washington, 1896.

while the top extends ninety feet west of the west end. The lower part of the formation here is a coarse, cross-bedded, grayish-green, micaceous sandstone. About one hundred feet above the bottom there is a four- or five-foot band of grayish, impure, friable sandstone frequently showing a prominent bluish coating. Scattering pebbles of various sizes up to two inches in longest direction are present. These are angular, subangular or well-rounded and of clear or smoky quartz, but seldom milky as in the conglomerate of the same formation on Town Hill. At various horizons above this there are thin bands of fine conglomerate, the pebbles of which are inclined to be of the nature of milky quartz. Near the middle of the section there is a space of nearly thirty feet which is largely taken up with shales, some of which bear slight traces of plant remains. The upper part of the section shows mostly grayish-green or reddish-green micaceous, flaggy sandstones with some interbedded grayish, greenish, yellowish or reddish shales.

In the Potomac gorge section the formation is made up of gray, cross-bedded sandstone with only a few widely scattered pebbles.

THE GREENBRIER FORMATION.

The Greenbrier formation, so-called from Greenbrier county, West Virginia, lies conformably upon the Pocono and outcrops in Allegany county only in a single narrow band extending high up along the eastern face of the Alleghany Front from the Maryland-Pennsylvania state line southward through the county, cutting across the Potomac river almost midway between Westernport, Maryland, and Keyser, West Virginia.

The formation consists mainly of limestone strata. Sandstones and arenaceous limestones are most prominently developed in the lower part. Shales preponderate near the middle while the upper part is mostly composed of highly fossiliferous and more nearly pure limestones. Many of the lower arenaceous beds show a peculiar banding on the weathered surfaces apparently as if they were highly cross-bedded.

The formation is well shown in only one place in the county, viz.,

at the mouth of Stony Run below the water-tank on the West Virginia Central Railroad, two miles southeast of Westernport. Even here some of the beds are hidden. In the only other places in the county where one might hope to get good sections, viz., along Braddock Run and along Jennings Run, the formation is largely concealed by soil and by talus from the heavy Pottsville sandstones and conglomerates above. As a result no measurements can be made in the northern part of the county, but judging from measurements in various places outside of the state, it seems quite certain that the formation grows continually thinner northward from Stony Run.¹ Much interest is attached to this formation because it is in great measure the Appalachian representative of the great Carboniferous limestones of the Central Mississippi states.

At the mouth of Stony Run the following section was made:

	Feet. Inches.	
Greenbrier-Mauch Chunk contact		
Heavy dark bluish gray fossiliferous limestone.....	4	6
Argillaceous shale. Fossiliferous, especially in the upper part. Drab colored on fresh surface, but inclined to show as a dull red shale on account of its prominent ferruginous surface coating		8
Massive bluish fossiliferous limestone	7	
Concealed	10	
Massive bluish fossiliferous limestone	1	6
Massive bluish, highly fossiliferous limestone, weathers very irregularly	3	6
Thinly bedded fossiliferous limestone with thin bands of olive-green fossiliferous shale	10	10
Concealed	9	
Reddish brown, much disintegrated sandstone		9
Concealed	20	
Heavy, pinkish green, mottled, slightly fossiliferous limestone	2	6
Concealed	11	
Red sandy shale with thin green layers near top and bottom	3	
Greenish red shaly arenaceous limestone	1	
Concealed	3	
Red sandy shale with a few thin shaly defined green argillaceous bands	32	

¹ Lesley, J. P. A Summary Description of the Geology of Pennsylvania in Three Volumes, vol. iii, part i, page 1791, Harrisburg, 1895. See also the Geologic Atlas of the United States, Piedmont and Franklin Folios.

	Feet.	Inches.
Concealed	6	
Red shaly sandstone	1	6
Massive sandstone in streaks or layers of pink, green and white	6	
Red arenaceous shale	10	
Red shaly sandstone	9	
Calcareous, pinkish gray sandstone	2	6
Concealed	7	
Shaly sandstone	1	6
Mostly concealed, some shaly sandstone showing.....	20	
Very arenaceous pinkish green limestone.....	26	
Concealed	5	
Bluish arenaceous limestone	7	
Concealed	8	

Below this comes a coarse grayish sandstone which is considered as marking the top of the Pocono, thus giving for the total thickness of the Greenbrier at this place two hundred and twenty-seven feet.

THE MAUCH CHUNK FORMATION.

The Mauch Chunk formation, which is very similar to the Canaan formation of the Piedmont quadrangle, receives its name from Mauch Chunk, Pennsylvania, where the formation is well shown. Like the preceding formation, it is exposed in Allegany county only along the eastern face of the Alleghany Front. This formation, together with the underlying Greenbrier, lies obscurely in the depressions extending in a line across the county between the heavy crest of Alleghany Front and the Pocono knobs a little lower down on the eastern face.

The Mauch Chunk is composed chiefly of red arenaceous and argillaceous shales, the argillaceous shales being a bright red and particularly prominent in the lower part. A little above the middle of the formation there lies in one almost continuous body about one hundred feet of soft, flaggy, fine-grained, reddish-green to brownish-red sandstone. The sandstones are very generally micaceous, as are also many of the middle and upper shales.

Between the Mauch Chunk and the Greenbrier there is a greenish brecciated sandstone which near the mouth of Stony Run is four feet thick. At the top of the Mauch Chunk there is also a four-foot transition band of highly brecciated reddish arenaceous limestones above



FIG. 1.—EXPOSURE OF JENNINGS SANDSTONE, CORRIGANVILLE.



FIG. 2.—EXPOSURE OF POTTSVILLE SANDSTONE, WESTERNPORT.

GEOLOGICAL SECTIONS IN ALLEGANY COUNTY.

which lie the lower flags of the succeeding Pottsville formation. This brecciated limestone can be seen to best advantage on the Cumberland and Pennsylvania Railroad one hundred twenty rods east of Barrelville. It is apparently continuous southward, since a similar brecciated limestone at the same horizon may be seen outcropping on the Keyser-Piedmont wagon road on the West Virginia side of the Potomac about one and one-half miles below Piedmont.

The total thickness of the formation in the Potomac gorge east of Westernport is about eight hundred feet. Along Jennings Run, twenty-five miles to the northeast, the space occupied by the Mauch Chunk and Greenbrier combined is approximately nine hundred and thirty feet or about one hundred feet less than the combined thickness of the two formations in the Potomac gorge.

THE POTTSVILLE FORMATION.

The Pottsville formation, which is approximately equivalent to the Blackwater formation of the Piedmont quadrangle, receives its name from Pottsville, Pennsylvania, near which place it is extensively developed. It is this formation which, at its easternmost outcrop in the county, makes the bold crest of Alleghany Front, and dipping westward passes beneath the surface and forms the massive floor of the Cumberland-Georges Creek coal district. It is to this formation more than to any other that is due the preservation of the present area of the coal-field. By its resistance to erosion it has governed the position of Alleghany Front, and although its eastern edge is greatly notched by Jennings Run, by Braddock Run and by the Potomac river, the latter having, indeed, cut into the formation westward across the synclinal axis, the formation nevertheless retains its full thickness throughout almost all of the area in Allegany county west of the easternmost Pottsville outcrop. The formation is slightly cut into by Georges Creek near the southern end of the coal basin, but passes beneath the creek bed a few yards north of the Cumberland and Pennsylvania car-shops in the northern suburbs of Westernport.

Messrs. N. H. Darton and Joseph A. Taff, in their general de-

scription of the Blackwater formation with which the Pottsville so closely agrees, mention the following important characteristics of the area in the northeastern part of the Piedmont quadrangle: "In the vicinity of Piedmont the uppermost and lowest sandstone beds are conglomeritic and are one hundred and ten and thirty feet thick respectively, while the medial sandstone is fine-grained and only fourteen feet thick."¹ The triple character of the formation can be readily made out by means of the many extensive outcrops of sandstone and conglomerate ledges; nevertheless there is no really good exposure of the whole formation found in the county, the softer strata being very largely concealed. Furthermore this, like most of the other Carboniferous formations, shows exceedingly rapid changes within short distances, so that a measurement in one locality, even if favorable conditions prevail, will but poorly suffice, so far as details are concerned, for an area only a short distance away.

It is perhaps for this reason alone that such wide discrepancy is observed in the details of all published sections made near the Potomac in the southern part of the Georges Creek basin. The following section, constructed from measurements made at various places, is believed to represent with reasonable accuracy the general character of the Pottsville formation in that vicinity:

	Feet.	Inches.
Pottsville-Allegheny contact		
Massive sandstone	20	
Coal, frequently impure or accompanied by black or gray shales [Westernport or "Two-foot" coal].....	2	
Shale and heavy sandstone	85	
Shale with coal streaks	30	
Flaggy sandstone and shale	12	
Coal	1	6
Impure fire-clay	8	
Flaggy sandstone	14	
Coal [Bloomington or "Railroad" coal].....	1	6
Shale	2	
Shale, flaggy sandstone and concealed	80	
Coal and coaly shale	3	
Black, yellow and gray arenaceous shales	7	
Greenish flaggy sandstone	30	
Pottsville-Mauch Chunk contact		
Total thickness of Pottsville	296	

¹ Geologic Atlas of the United States, Piedmont Folio, Washington, 1896.

No good measurement of the Pottsville can be obtained in the northern part of Allegany county, but the following section has been measured a little north of the state line near Wellersburg, Somerset county, Pennsylvania, in the gap of Gladdens Run through Little Allegheny Mountain:¹

	Feet.	Inches.
Massive sandstone	75	
Mount Savage coal	4	
Mount Savage fire-clay	7	6
Conglomerate sandstone	125	
Dark, shaly sandstone	10	
Shale	1	
Coal and shale		8
Impure fire-clay	10	
Dark shales with iron ore	20	
Massive sandstone	35	
<hr/>		
Total thickness	288	2

Along the Baltimore and Ohio Railroad west of Piedmont, West Virginia, is a coal seam popularly known as the Railroad Seam, which has been named the Bloomington coal, and near the top of the formation is a two-foot seam named the Westernport coal.

THE ALLEGHENY FORMATION.

The Allegheny formation, identical with the Allegheny river series of Pennsylvania, immediately follows the Pottsville, and like it, underlies most of the Georges Creek basin. It outcrops on the eastern side of the basin high up on the western slope of Dans and Little Allegheny mountains. In a similar manner its western edge shows along the eastern slope of Savage Mountain, but of this last outcrop Allegany county includes only a small portion near the Maryland-Pennsylvania line. The entire thickness of the formation is shown in the southern part of the basin on the hillsides along the Potomac but northward the formation disappears beneath the bed of Georges Creek one mile below Barton.

The formation consists mainly of irregularly interbedded shales and sandstones with several coal seams of greater or less importance.

¹ White, I. C. Stratigraphy of the Bituminous Coal Fields of Pennsylvania, Ohio and West Virginia, U. S. G. S. Bull. No. 65, p. 186, Washington, 1891.

At the base is the poorly exposed Bluebaugh seam which has been opened at Warrior Run. About 35 feet above this is the Parker seam shown in various parts of the coal basin and supposed to be the equivalent of the Clarion coal of Pennsylvania. About the center of the formation is the Davis or Six-foot coal, the most important of all the coals in this formation. It is supposed to be the equivalent of the Lower Kittanning of Pennsylvania. About 30 feet beneath it streaks of coal may usually be found which together compose the unworked Split-six. At the top of the formation is the Thomas or Three-foot seam.

Most of the sandstones are thinly bedded and disintegrate easily, so that the face of the outcrop is generally hidden by a gently sloping cover of loose shale and soil delimited by the more massive Pottsville sandstone below and the heavy Mahoning sandstone above.

The following section was measured near the Franklin gravity plane a short distance from the mouth of Savage river:

	Feet.
Sandstone, apparently the Mahoning	
Concealed	25
Sandy ferruginous shale	60
Sandstones and concealed	50
Sandstone, flaggy near top	60
Shale	6
Coal [Davis or "Six-foot"]	6
Concealed	30
Flaggy and shaly sandstone	61
Coal [Parker]	1
Shale	19
Conglomeritic sandstone of Pottsville	—
Total thickness of Allegheny formation.....	318

A more detailed section was obtained as follows near Franklin village on Georges Creek.

	Feet.
Massive sandstone, apparently the Mahoning.....	
Greenish shaly sandstone. A coal vein near the top	
[Thomas]	55
Massive sandstone	24
Ferruginous shale, showing spheroidal weathering.....	3
Fine black and brown shales	8
Grayish green, slightly nodular shale	10
Fine grayish green shale	4
Arenaceous shale	9
Greenish sandstone and shale	26

	Fect.
Shaly sandstone	6
Fine shale and concealed	9
Shaly sandstone	13½
Concealed	30
Coal [Davis]	6
Sandstone, shale and concealed	7
Flaggy sandstone	16
Massive sandstone	4
Shale	2
Coal [" Split-six "]	3
Concealed	90

Total thickness of Allegheny formation.....325½

Professor I. C. White, in Bulletin 65 of the United States Geological Survey, gives the following measurements for the vicinity of Westernport:

	Fect.	Inches.
Coal, Upper Freeport [Thomas].. { Coal	2	
	Shale and bone....	1
	Coal	2 5
Concealed	10	
Shale, bluish	10	
Coal, Lower Freeport	2	
Fire-clay	2	
Concealed	10	
Sandstone, hard	2	
Sandstone, shaly	5	
Shales, sandstones and concealed	55	
Coal, Upper Kittanning..... { Bituminous slate ..	5	
	Coal	2 7
Dark shales and concealed	10	
Massive sandstone, gray	50	
Shales, drab	5	
Coal, Upper Kittanning [Davis]. { Coal, slaty	1	
	Coal, bony	8
	Coal, good	1 4
	Slate, hard	½
	Coal, good	2 6 5
Fire-clay, sandy	3	6½
Shales, with nodular iron ore	2	
Fire-clay, impure	4	
Flaggy sandstone	20	
Concealed	25	
Fire-clay, sandy	10	
Flaggy sandstone and sandy shales.....	25	
Concealed and sandy shales	40	
Total	307	6½

In the northern part of the coal basin the thickness cannot be learned, nor is there a good exposure anywhere along the lines of outcrop on the eastern and western borders of the basin.

Near the mouth of Georges Creek, as seen beneath Mr. Merrill's mine, there is a coal seam almost thirty feet below the "six-foot." The section obtained at Mr. Merrill's mine for this part of the formation is as follows:

	Feet.
Coal [Davis]	
Shale	9
Sandstone and shale	11
Shale	4
Shaly sandstone	1
Shale	4
Coal ["Split-six"]	3

THE CONEMAUGH FORMATION.

The Conemaugh formation, so-called from Conemaugh river, Pa., follows the Allegheny in regular order and lies within the area outlined by that formation. In the northern part of the basin the Allegheny has been cut deeply by Jennings Run and its tributaries, while at the southern end Georges Creek has made a long incision into it, the bifurcation extending northward to within one mile of Barton.

The Conemaugh, formerly called the "Barren Measures," is largely a shale formation. A sandstone, sometimes rather massive, is generally found near the bottom. This is apparently equivalent to the Mahoning sandstone of Pennsylvania. A second sandstone occasionally quite massive, is found twenty or thirty feet below the top. The latter sandstone is generally not less than twenty feet thick and is sometimes conglomeritic, especially in the lower parts. Two hundred yards east of the Hofman mine opening an exposure above and below the railroad switch gives a thickness of thirty-eight feet with neither the top nor bottom shown. A few rods east of Eckhart on the National Road near the Cumberland and Pennsylvania Railroad, thirty feet of the sandstone is exposed, but here also the top and bottom are concealed. Likewise, immediately east of the long railroad bridge near Detmold Run, fourteen feet is exposed, and in

the village of Miller, east of Lonaconing, twenty-five feet is shown, but in each case the top and bottom are hidden. This sandstone is flaggy near the top and, like most of the other Coal Measures sandstones, is highly charged with iron, contains much mica and is highly cross-bedded.

A sandstone which is frequently conglomeritic is found a little below the middle of the formation. Thirty-six feet of this conglomeritic sandstone is shown to good advantage at Barton on the hillside south of the Potomac tramway.

The shales are chiefly argillaceous, and the coals, of which there are several, are usually impure; one coal seam of some importance known as the "Four-foot" or Barton coal is approximately 250 feet above the bottom of the formation. Irregular beds of iron ore are frequent and two or three limestones are present. A limestone bed, perhaps the thickest limestone of the formation, is poorly exposed on the Potomac gravity plane about 235 feet below the top of the formation. It is bluish-black in color, slightly fossiliferous and six feet thick. It measures as follows:

	Feet.	Inches.
Massive limestone	1	6
Shaly limestone		6
Massive limestone		8
Shaly limestone		4
Massive limestone	3	

Another limestone was found in a ravine at the roadside one mile west of Mount Savage. This is apparently about one hundred feet higher than the limestone at the Potomac Plane. The measurement of the entire exposure here is as follows:

	Feet.	Inches.
Concealed		
Black shale		10
Very coaly shale		3
Black, somewhat coaly shale	1	8
Impure coal	2	8
Black shale with very thin coal streaks		4
Coaly shale	1	1
Coal, apparently all good	2	4
Shale, dark above, gray in lower part	1	5
Clay		7
Massive, bluish gray, argillaceous limestone	2	1

	Feet.	Inches.
Massive light gray argillaceous brecciated limestone.....	1	9
Very argillaceous limestone	4	6
Soft weathered shale		4
Iron-ore band		4
Black coaly shale	2	
Concealed		

Thirty feet below this section there is a thin highly ripple-marked sandstone exposed in the road-bed two hundred yards west of the coal outcrop.

For a complete section of the entire formation no more detailed section can be given than that published by Professor P. T. Tyson¹ many years ago, as obtained from measurements made on the eastern side of Dug Hill near Lonaconing, the hill having received this name on account of the excavations made especially for these measurements on Laurel Run and on Mill Run. It is not easy to decide just which stratum of Professor Tyson's section coincides with the lower limit of the Conemaugh, but the section as given below is believed to have its lowest measurement within a few feet of the contact. Although on account of the variability of the strata the measurements may seem to have been taken more in detail than necessary and less attention given to recording the degree of purity of the various coal seams and iron-ore bands than may be desirable for economic purposes, nevertheless the section will perhaps always remain an important one for this division of the Coal Measures at Lonaconing. In the absence of good exposures elsewhere it has in the past been largely depended upon as a guide for other parts of the coal basin.

The section is as follows:

	Feet.	Inches.
"Big Vein" coal [from Dug Hill measurements].....		
Shale with iron ore at the top.....	12	
Fire-clay	3	
Limestone	1	6
Shale	15	6
Sandstone, fine-grained	29	
Shale	27	6

¹ Proc. Amer. Philos. Soc. xi, 1871, pp. 9-13.

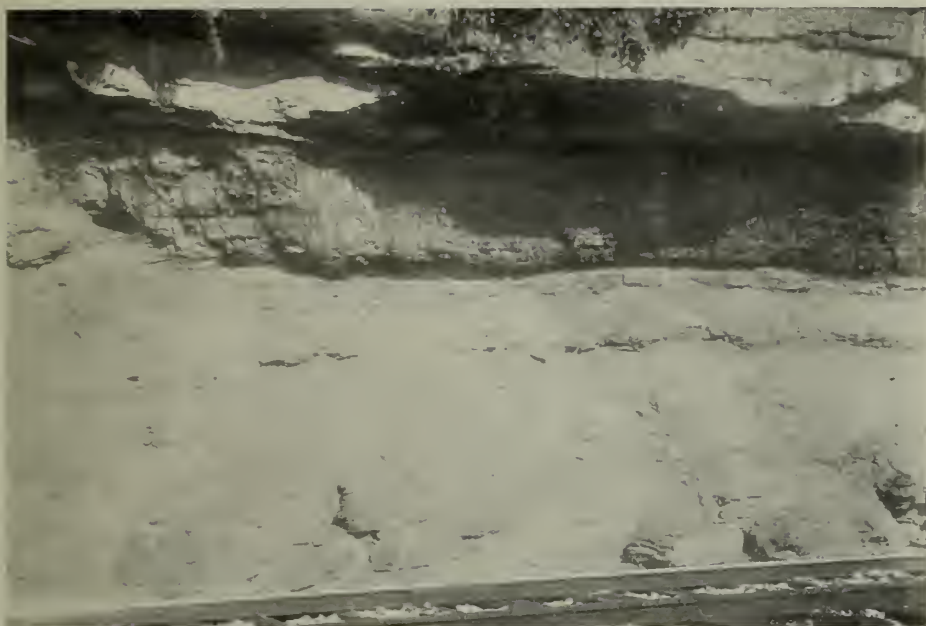


FIG. 1.—THE "RAILROAD SEAM" NEAR PIEDMONT, W. VA.



FIG. 2.—VIEW OF "BIG VEIN" COAL, IN OCEAN MINE, NO. 3.

	Feet.	Inches.
Coal	2	6
Shale	4	
Shale with iron ore at the top.....	16	8
Shale, ferruginous	1	
Coal	3	9
Shale	1	
Coal	1	
Shale, with three bands of iron ore	2	6
Fire-clay with iron ore	3	
Shale		6
Coal	1	
Shale with iron ore		7
Fire-clay with iron ore nodules	2	
Shale		6
Coal	1	6
Shale	2	6
Fire-clay with two bands of iron ore	5	6
Sandstone	1	6
Shale with four bands of iron ore	6	6
Shale with two bands of iron ore nodules	6	6
Iron ore		7
Shale with iron ore	4	3
Coal		6
Shale with iron ore		6
Coal	1	6
Shale	2	
Coaly shale	2	3
Shale with iron ore	2	2
Coal	2	1
Shale		6
Fire-clay with iron ore	2	8
Shale with iron ore	4	10
Shale, ferruginous	2	6
Iron ore	1	6
Coal		3
Shaly sandstone	2	
Shale	4	6
Coal	2	6
Limestone	3	
Fire-clay	3	6
Coal		8
Shale	1	6
Shale, ferruginous	1	6
Shale	1	
Coal	1	3
Shale	1	3
Coal	1	6
Shale	1	6

	Feet.	Inches.
Coal	1	6
Shale, brown	2	8
Shale, arenaceous and nodular	5	
Shaly sandstone	8	
Shale	4	6
Coal	1	6
Fire-clay	7	4
Shale, ferruginous	5	
Shale with nodules	7	
Shale, ferruginous	2	
Shale	1	
Sandstone	39	
Shale	15	
Fire-clay with iron ore	3	
Limestone	6	
Fire-clay with iron ore	2	
Shale	10	
Sandstone [from measurements on Laurel Run].....	44	
Coal		8
Shale		10
Limestone	2	2
Sandstone	23	6
Shale	6	
Hard black band	6	
Shale, very ferruginous	6	
Shale [from measurements on Mill Run].....	4	6
Coal, shaly, hard, good	5	8
Fire-clay, sandy	4	
Ore in shaly fire-clay	6	
Limestone	6	
Sandstone	33	
Shale	9	6
Fossiliferous ferruginous shale	11	

Total thickness of strata now considered as Conemaugh, 495 6

An excellent section recently obtained by Professor Charles S. Prosser of the Maryland Geological Survey gives the thickness of the Conemaugh on Phoenix Hill two miles below Barton as approximately 630 feet. This section is as follows:

	Feet.	Inches.
"Big Vein" coal		
Black shales with thin layers of sandstone.....	41	6
Concealed in part	93	6
Thin-bedded sandstone with coal streak at base	10	
Black clay shales	4	6

			Feet.	Inches.
Coal	2½ in.			
Black clay shale...	1½			
Coal	7			
Black clay shale...	2 ft. 0			
Coal	11			
Black clay shale...	7	The Franklin or so-called		
Coal	3	“Dirty Nine-foot”	10	4
Black clay shale...	5			
Coal	5			
Black clay shale...	2	4		
Coal	2	6		
Fire-clay and shales			24	
Brownish sandstone			2	6
Concealed			23	
Coal				3
Concealed			15	
Drab to yellowish shales			16	6
Coal				9
Sandy shales with iron nodules			14	9
Mostly concealed			38	
Shales			17	6
Bituminous shale			1	6
Shales with limestone concretions			21	
Concealed			25	
Shales and sandstone			28	9
Brownish gray compact sandstone			1	
Concealed, probably containing Barton or “Four-Foot” coal			37	6
Yellowish gray shales			2	
Coal				4
Shales and thin-bedded sandstones			28	6
Thin-bedded sandstones and shales			6	
Impure fire-clay and shales			10	
Yellowish sandy shales			20	
Bluish to yellowish shales			23	
Massive sandstone			12	
Concealed			20	
Coal			1	9
Fire-clay			2	6
Yellowish shales with iron nodules			15	6
Massive sandstone			1	
Concealed			20	3
Olive to yellowish shales			11	6
Concealed, with sandstone blocks			8	9
Massive sandstone			3	9
Concealed and sandy shales			21	
Conemaugh-Allegheny contact				

Total thickness of Conemaugh.....630+

THE MONONGAHELA FORMATION.

The Monongahela formation received its name from the Monongahela river, along which stream it is well developed. The floor of the "Big Vein" coal distinctly marks the base of the formation, while its upper limits in the few small areas where the full thickness still remains is marked by the roof of the Koontz (Waynesburg) coal.

The formation has been much dissected by erosion and, retaining only a minor proportion of its former distribution, is broken into many distinct areas. The most extensive of these lies around and largely to the south of Frostburg. Its northern end lies upon and helps to make the high transverse divide which separates the drainage of Jennings and Braddock runs from that of Georges Creek, and has thus survived the cutting that has so seriously affected the northern and southern portions of the basin. This area is very irregular in outline. It extends southward to Lonaconing, and one narrow area reaches northward to within almost half a mile of Mount Savage. Three of its prominent westerly projections extend across the county line into Garrett county. An oval area of small extent lies upon the county line about one and one-half miles southwest of Frostburg as an outlier of the above-mentioned larger area from which it has been cut off by the branches of Winebrenner Run, a tributary of Georges Creek. North of Frostburg and west of the Cumberland and Pennsylvania Railroad there is an area of considerable size which is separated from the larger area to the south by the headwaters of Jennings Run. A rapidly disappearing remnant of Monongahela, covering perhaps twenty acres, caps a prominent hill north-northwest of Mount Savage, one-half mile south of the state line. The area is oval in shape and the greatest thickness above the "Big Vein" is less than seventy-five feet.

In the southern part of the basin east of Georges Creek there are several isolated areas. The largest of these, lying southeast of Lonaconing, covers less than three square miles and retains the full thickness of the formation. None of the others reach an area of two square miles and none show the full thickness. Several areas lie west of Georges Creek south of Koontz Run, but only one of these,

the small one west of Moscow, is wholly within Allegany county. That just west of Lonaconing is one of the largest and retains the full thickness of the formation.

The Monongahela formation is composed almost wholly of easily disintegrating materials. Only rarely do the sandstones become sufficiently thick and massive to form noticeable topographic features, although in Washington Hollow near Eckhart and on the hillsides east of the village of Miller many loose sandstone boulders were found which are quite massive and conglomeritic. The surface of the hillsides covered by the Monongahela is smooth and gently sloping. The characteristic topographic feature commonly known as the "bench," which is so frequently seen above the Big Vein, is due generally to the relatively easy weathering properties of the coal and to the hardness of the heavy underlying sandstone.

Near the top of Westernport Hill above the Franklin tramroad is a micaceous sandstone about twenty-five feet thick. This is near the middle of the formation and apparently varies greatly in character. Other thinner sandstones are interbedded among the shales, but their exact location is generally not easy to determine.

The shales of the Monongahela are arenaceous and argillaceous and vary in color from a light gray through green and brown to an intense black. Iron-ore bands are not infrequent, and in the lower part of the formation they are sometimes of considerable thickness.

The number of persistent limestones is not definitely known. Some of those which in places show good exposures are evidently so lenticular in character that they can seldom be safely correlated with those in distant areas. In the mine shaft sunk by the Borden Mining Company three miles south of Frostburg, two limestones were found about forty and fifty feet above the "Big Vein" coal. In the Consolidation Coal Company's pumping shaft not far distant two limestones were also found, one thirty-three feet above the "Big Vein," while the other was more than two hundred feet above. An additional limestone bed is exposed near by but a few feet above the mouth of the shaft. One mile north of Frostburg along the upper railroad track near the New York mine, loose boulders of a massive

limestone are shown which indicate a stratum not more than fifty feet above the "Big Vein" coal. Likewise, in the vicinity of the Koontz mine, a variable limestone is found about forty feet above the "Big Vein," and one-half mile west of Vale Summit in a ravine on the west side of the Georges Creek and Cumberland Railroad a limestone is found at about the same horizon. Near the new furnace, one-half mile west of the New Detmold mine, a three and one-half foot bed is shown one hundred and five feet above the "Big Vein," while near the top of Westernport Hill loose limestone boulders indicate a bed there occupying about the same position.

The limestones frequently appear brecciated on weathered surfaces, are usually slightly fossiliferous and are almost invariably dark in color when fresh.

Owing to the detritus which covers the well-weathered hillsides in the northern and in the southern ends of the basin, good sections of the Monongahela can be obtained only near the central part. Measurements made by Professor Tyson near Lonaconing, and by the Consolidation Coal Company at their pumping shaft, include all of the strata now considered as Monongahela, and since the Borden Mine shaft has passed through the lower half of the formation, we have three good measurements in as many different places. The measurements obtained at Borden Shaft are as follows:

	Feet. Inches.	
Top of shaft		
Hard gray sandstone	6	6½
Shale	12	6
Coal [Tyson]	3	4
Shale	8	5½
Sandstone	2	4
Shale and sandstone	5	2
Sandstone	1	
Shale	7	
Limestone	2	
Shale	2	9
Limestone and shale	7	8
Shale	8	9½
Coal and shale [Redstone]	8	3
Fire-clay	1	4½
Black shale	18	2½
Sandstone		4

	Feet.	Inches.
Shale	2	7
Elkgarden or "Big Vein" coal.....	12	6 $\frac{1}{4}$
		<hr/>
Total thickness exposed	110	9 $\frac{3}{4}$

In the Consolidation Coal Company's shaft, which is situated about two miles south of Frostburg, the measurements are:

	Feet.	Inches.
Top of shaft		
Unconsolidated surface material	8	5
Limestone with boulders	5	7
Siliceous fire-clay	3	11
Sandstone		10
Shale	4	10
Sandstone	1	8
Shale	20	
Coal		5
Shale	5	8
Sandstone	14	2
Shale	38	
Coal }		10
Shale } [Tyson]	3	
Coal }	1	8
Shale	16	
Sandstone	4	
Shale	25	
Sandstone	1	
Coal	2	6
Shale	18	
Sandstone		10
Shale	9	6
Limestone	5	6
Shale	7	8
Coal and shale [Redstone]	7	4
Shale	18	9
Sandstone	1	2
Coal and shale	3	7
Elkgarden or "Big Vein" coal	9	6
		<hr/>
Total thickness exposed	239	4

Professor Tyson's measurements are as follows:

	Feet.	Inches.
Shale above		
Coal	6	
Limestone with shale	12	
Fire-clay	13	9
Concealed	3	9

	Feet.	Inches.
Shale with iron nodules	27	3
Shale	27	9
Fine-grained sandstone	3	6
Shale	2	6
Coal with two inches of shale	4	3
Fire-clay	10	
Coal	3	6
Fire-clay	3	
Coarse shaly, micaceous sandstone	51	
Shale	42	6
Coal	4	6
Shale	2	
Coal	1	
Shale	4	9
Coal		10
Shale	1	3
Shaly sandstone	1	
Ferruginous shale	4	8
Elkgarden or "Big Vein" coal	14	
<hr/>		
Total thickness of Monongahela at Lonaconing.....	238	9

THE PERMIAN.

THE DUNKARD FORMATION.

Several of the highest hills near the central part of the coal basin are capped by strata which are equivalent to the Dunkard series of Pennsylvania. The largest of these areas, on which Frostburg is situated, caps the irregularly shaped divide which separates the headwaters of Georges Creek, Braddock Run and Jennings Run. An area of considerable size lies to the north of Lonaconing and another lies to the west. Both extend into Garrett county. A much smaller area lies to the south. A dumbbell-shaped area lies west of Ocean and a small oval patch lies north of Upper Ocean. A fair-sized area lies also between Ocean and Vale Summit.

Stratigraphically the Dunkard formation conformably follows and includes everything above the Monongahela. The higher slopes of the hills on which the formation lies are in every case well rounded and show almost no natural outcrops. Shales and limestones are known to be prominent, sandstones are present but apparently not

important, and coal-beds, although shown in some places, seem to be of little consequence. The shales have a dull reddish-green color, but were seen only where considerably weathered. The lowest limestone observed is exposed in the Cumberland and Pennsylvania Railroad cut near the Consolidation Coal Company's pumping shaft two miles south of Frostburg. This is composed of an upper dark massive fossiliferous layer twenty-eight inches thick and a lower, somewhat shaly bluish-gray stratum forty-three inches thick. About 300 feet above this, on the hill east of the pumping shaft, there is an abandoned limestone quarry in which the partially exposed limestone containing small scattering fossils seems to have a thickness of about six feet. Fifteen feet higher there is another thinner limestone as indicated by loose blocks on the surface. A very argillaceous limestone seven and one-half feet thick is exposed about 250 yards north of the Frostburg tunnel. This seems to be several feet above the bottom of the Dunkard formation and possibly lies at the same horizon as the one seen in the railroad cut near the pumping shaft.

But little can be said of the coal seams in the Dunkard formation, and so far as known none are more than twelve inches thick. One bed having this thickness is exposed a few feet above the limestone north of the Frostburg tunnel. Others were seen at this place, but they were of much less thickness. Near the pumping shaft two coal seams are known to lie more than 300 feet above the bottom of the formation, but their thickness could not be learned.

No detailed section of the formation can be given, but its greatest thickness is about four hundred feet.

The Permian character of these strata has been maintained by some, and they are classified as Permian in Volume One of The Maryland Geological Survey in conformity with the results obtained by Professors Fontaine and White in their study of similar strata in Pennsylvania and West Virginia. Their work in the higher strata there has shown a gradual decrease and final disappearance of coal, a great change in plant life and important changes in physical conditions. Lithologically, in Maryland, the Dunkard appears but little different from the higher Coal Measures except in the lesser importance of its

coal seams and possibly in the greater abundance of its limestones. The fossils thus far found in the formation are not numerous and have not yet been described. All of those collected have been confined wholly to minute forms found in the limestones. The plant form *Pecopteris elliptica* described by Bunbury, is thought to have come from the Dunkard formation, but this is not certain.¹

THE PLEISTOCENE.

THE ALLUVIAL AND OTHER LATE DEPOSITS.

Well-rounded boulders and coarse gravels of quartzite and conglomerate are found in the western part of the county scattered loosely upon the hillsides, extending at Cumberland as much as 300 feet above the Potomac river, or a little more than 900 feet above tide. At Piedmont, West Virginia, where the river bed is 300 feet higher, similar boulders have been found as much as 1060 feet above sea-level. These and other deposits of like nature have been described and discussed by Professors J. J. Stevenson and I. C. White, both of whom consider them of glacial or post-glacial age.²

At a considerably lower level in several places along the Potomac river deposits of clay, coarse gravels and boulders are found which sometimes show coarse stratification. This is particularly noticeable in the vicinity of Cumberland and in some of the Baltimore and Ohio and West Virginia Central Railroad cuts between Cumberland and Westernport, as well as along the Baltimore and Ohio Railroad near the eastern part of the county between Paw Paw, West Virginia, and the mouth of Sideling Hill Creek. The gravels and boulders are usually well-rounded and polished and consist for the most part of fragments of Paleozoic materials such as are found in

¹ Fontaine, Wm. M., and White, I. C. The Permian, or Upper Carboniferous, Flora of West Virginia and S. W. Pennsylvania. Second Geological Survey of Pennsylvania, Report PP, p. iii, Harrisburg, 1880.

² Stevenson, John J. On the Surface Geology of Southwest Pennsylvania and adjoining portions of Maryland and West Virginia. A. J. S., vol. xv, 1878, pp. 245-250.

White, I. C. Rounded Boulders at high altitudes along some Appalachian Rivers. A. J. S., vol. xxxiv, 1887, pp. 374-381.

the immediate vicinity. Near the railroad tunnel just north of Paw Paw the stratification may be seen to excellent advantage, the deposits there extending upwards as much as sixty feet above the bed of the Potomac river. Some of the materials found here have evidently been carried a considerable distance, since among them are chert fragments, evidently from the Helderberg formation, the nearest outcrop of which is more than ten miles distant. Distinct stratification may also be seen in a few favorable places between Cumberland and Westernport.

It may be of interest to describe in this connection a fossiliferous limestone-chert breccia found by the author between Cumberland and Westernport. Professor I. C. White has described an apparently similar deposit along Patterson Creek in West Virginia, but does not mention the presence of fossils.¹ The two deposits possibly have the same origin. The breccia is made up of small angular, slightly water-worn, frequently flattened fragments of chert and limestone, evidently derived from the Helderberg formation on which it is found. The cementing material is lime. It is hard but vesicular and forms no little portion of the entire mass.

As yet only a small collection of this breccia has been examined, but among the fossils thus far found the following have been identified by Professor H. A. Pilsbry:

Pupa (Bifidaria) armifera, Say.

Zenitoides minusculus, Binn.

Strobilops, probably *virgo*, Pils. or *affinis*, Pils.

Helicina occulta, Say.

Helicodiscus lineatus, Say.

Polygyra hirsuta.

Polygyra albocabris, Say (?).

Polygyra, species undetermined.

The breccia is apparently of quite recent origin, and there is some reason for believing that it may be forming at the present time. Professor Pilsbry says that *Helicina occulta* is one of the most abun-

¹ White, I. C. Rounded Boulders at high altitudes along some Appalachian rivers. A. J. S., 3d series, vol. xxxiv, 1887, pp. 374-381.

dant and characteristic fossils of the Iowa loess and is now almost extinct, being confined to a few very restricted though widely separated areas, and that it has not hitherto been known to occur in Maryland, either recent or fossil. The other species have been previously recognized as living in Maryland.

STRUCTURE.

THE ORLEANS ANTICLINE.

The Orleans anticline, known in Pennsylvania as the Whip Cove anticline, enters Allegany county from the north near the point where Sideling Hill Creek crosses the state line. It may be considered as including the area covered by the Jennings formation east of Town Hill. The several small patches of Hampshire that have been carved out by the meanderings of the Potomac river and Sideling Hill Creek along the eastern side may also be considered with this anticline, although the easternmost parts of the areas might perhaps be more conveniently considered with the Sideling Hill syncline outside of the county.

The exact position of the main anticlinal axis on the state line is concealed, but it is apparently east of Sideling Hill Creek and the Second Geological Survey of Pennsylvania from data collected in that state has so indicated it. West of the creek the dip was observed in various places in the bottom of the ravine which runs nearly parallel with the state line. Two hundred yards west of the creek there is a very perceptible anticline, although the exact position of the axis is concealed. The west limb of this anticline dips quite regularly 27° to 28° W. East of the axis the dip is complicated. At a point one hundred yards west of the creek the dip is 38° E. This rapidly decreases eastward to almost zero, then as rapidly increases again to 50° E., which in turn quickly decreases to zero, this last measurement having been obtained in the bed of Sideling Hill Creek. East of the creek along the state line the rocks are concealed.

The anticline running nearly parallel with Town Hill extends entirely across the county, including the two larger West Virginia areas

that have been carved out by the sinuosities of the Potomac river. In general the fold is composite, as is indicated by the presence of various small anticlines situated near where the main axis evidently lies.

On the National Road, about one mile south of the state line, the various attitudes of the strata are well shown and three anticlines are there disclosed. The evidence seems to indicate that the main axis crosses the National Road about one mile west of Sideling Hill Creek. At this point there is a very perceptible anticline, the west limb dipping 43° W., the east limb dipping 14° E. This last dip changes within one-half mile east to 21° W., and this a little further east is followed by an anticline, the eastern limb of which dips 52° E. At the edge of the county, where the road crosses the creek near the Hampshire-Jennings contact, the dip is 36° E. West of the main anticlinal axis as located, the dip rapidly swings around from 43° W. through zero to 46° E., but one-half mile west there is another anticline with the west limb dipping 4° W. Continuing westward the dip is slight until the Jennings-Hampshire contact four miles west is reached, near which place there is a small anticline with east and west limbs dipping 60° E. and 41° W. respectively. This is followed by strata dipping more and more gently westward.

Southward from the National Road the anticline turns a little more to the east, passing only a few rods west of the great bend in Sideling Hill Creek, where the east limb dips 48° E. and the west limb 61° to 85° W. Continuing southward the axis crosses Fifteenmile Creek three-fourths of a mile west of Little Orleans, the village which suggested the name here used in describing the anticline. Where the axis crosses the creek the east limb of the anticline dips 14° E., the west limb 50° W. The dip of the east limb gradually increases eastward until at the mouth of the creek the dip is 90° . On the Potomac river, one-fourth mile north of Little Orleans, a dip of 54° W. is shortly followed to the east by a dip of 78° W. Beyond this, eastward, the dip passes somewhat rapidly through zero to 57° E., near which attitude the strata remain until within two hundred yards of the mouth of Sideling Hill Creek. Here there is a small syncline

with west limb dipping 44° E. and east limb dipping 53° W. At the mouth of the creek the dip is 34° W. On Fifteenmile Creek, west of the main antilinal axis, the strata dip on an average about 40° W. until near the Jennings-Hampshire contact, where there is a syncline with east and west limbs dipping 40° W. and 38° E. respectively.

South of Fifteenmile Creek the axis extends in a more southerly direction and cuts across the West Virginia projection about one mile west of Doe Gully tunnel on the Baltimore and Ohio Railroad and almost parallel with it. Where the antiline is first crossed by the Potomac south of Fifteenmile Creek its limbs dip 82° W. and 63° E. Along the river west of the axis the dip of the strata changes gradually, decreasing to 47° W. at the Jennings-Hampshire contact near the big bend in the river. East of the axis also the dip is pretty regular, passing gradually through 74° E., 54° E., 44° E., 54° E., 42° E. to 56° E., the last measurement, 56° E., having been made one mile east of Doe Gully at the end of the bend in the river. The strata through which Doe Gully tunnel is cut dip 53° E. near the north end and 54° E. near the south end, the strike being 34° E. in a line with the tunnel. In the West Virginia area west of the tunnel, as well as in most of the Maryland peninsular area immediately to the south, the dip is not shown. However, going up the Potomac from the south end of the tunnel, the dip can be pretty frequently made out. The antilinal axis having turned considerably to the west of its usual direction, crosses the river about one mile below Bairds on the Baltimore and Ohio Railroad, where the limbs of the antiline dip 74° W. and 45° E. Along this east and west section of the river, as in the one near Doe Gully Station, no secondary folding can be observed. The dip of 74° W. gradually increases to 82° W., then slowly decreases to 61° W. at the bend of the river near Bairds. East of the axis the dip gradually passes through 42° E., 54° E., 43° E., 36° E., 39° E., and 54° E., the latter dip, 54° E., being shown at the Jennings-Hampshire contact as well as farther east at the bend in the river.

Apparently taking more nearly its general course of S. 25° W.,

the axis passes across the next West Virginia area where its position is hidden but is shown again on the Potomac between Bairds and Magnolia in a much confused condition. Here five anticlines appear. The main axis is situated somewhere west of the canal tunnel north of Paw Paw and apparently crosses the river about one-half mile west of the tunnel. West of the axis the dip oscillates rapidly, 69° being the dip of the steepest strata observed. East of the axis the dip is less changeable, although considerable fluctuation occurs. Immediately above the opening at the northern portal of the canal tunnel a small asymmetric anticline is exposed which dips 44° W. and 28° E. The tunnel, which is three thousand four hundred and forty feet long, runs nearly with the strike, but at the south end this anticline is not seen, the dip being 36° E. At the north end, where a very large amount of rock has been removed in order to provide a suitable approach to the tunnel, a most magnificent slickenside surface of more than one thousand square yards is exposed. The surface has a slant of 52° W. and, although uncovered more than half a century ago, it is everywhere marked by the usual slickenside striation and still retains a high polish.

In the Hampshire formation at the bend in the river at Magnolia the dip is 78° E. Going westward the dip gradually grows less until it reaches 21° E. at a point about three-fourths of a mile west of the easternmost part of the bend. On the Maryland side of the river opposite the north end of the Paw Paw tunnel on the Baltimore and Ohio Railroad there is a strong anticline, the east line of which dips 30° E. The dip of the west limb could not be determined. At each end of the tunnel the dip is 41° E. Across the river from Paw Paw at the edge of the canal a small anticline is exposed. It is also shown a short distance further north at the canal, and is presumably identical with the one seen at the north end of the canal tunnel.

Almost three-fourths of a mile west of Paw Paw on the county road there is a fold which apparently locates the axis of the main anticline. The west limb has a dip of 80° , which gradually decreases to 40° one-fourth of a mile further west. The dip of the east limb is 71° and this decreases to 40° within a distance of eighty rods. South

of the county road the antielinal axis apparently becomes much deflected to the west, although this cannot be definitely proven.

Along the river on the south side of the county only one obscure antieline was detected and this is about one hundred rods west of the point where Little Cacapon river enters the Potomac. The west limb dips 66° W., but gradually and uninterruptedly grows less steep. The dip of the east limb is not known, but opposite the mouth of Little Cacapon the dip is 32° E. In the absence of other evidence the Orleans anticline is considered as passing across the river and out of the county along the position of this, the only observed antieline in the region.

THE TOWN HILL SYNCLINE.

The Town Hill syncline, extending entirely across the county, has the general direction of N. 25° E., and may be considered to embrace the area covered by the two long narrow belts of Pocono at the top of Town Hill, the flanking area of Hampshire in the hollow of which the Pocono rests, together with that part of the Jennings included in the western slope of Green Ridge. So far as can be observed, this syncline is but little complicated, being particularly simple and symmetrical where cut through by the Potomac river. On the National Road near the eastern Pocono-Hampshire contact the dip is 24° W. Going eastward the dip slowly increases to 48° W., this observation having been made near the fork in the road about one mile west of Piney Grove. Near here the dip quickly changes through zero to 52° E., which position the strata retain a few rods west of Piney Grove post-office. From this point eastward the strata rapidly regain their westerly dip and at the post-office the dip is 57° W. One-fourth of a mile further east the dip is 23° W. This is soon followed by a fold, the presence of which is indicated by the position of the strata one-half mile east of the post-office where the dip is 25° - 30° E. Beyond this the influence of the Orleans anticline becomes paramount.

On the National Road, west of the top of Town Hill, one small symmetrical antieline is seen with limbs dipping 28° . This is one-half mile west of the Pocono-Hampshire contact. Continuing west-



FIG. 1.—FAULTED ANTICLINE IN SILURIAN STRATA, FIVE MILES SOUTHWEST OF CUMBERLAND.



FIG. 2.—SHARP FOLDS IN DEVONIAN SANDY SHALES, NEAR LITTLE ORLEANS.

ward this is followed by a regular easterly dip, gradually changing through 28° E., 38° E., 45° E., 32° E., 53° E., 35° E., and 50° E. The dip of 38° E. was measured at the side of the creek between Town Hill and Green Ridge, that of 32° E. is shown on the summit of Green Ridge near the Hampshire-Jennings contact, while the measurement of 50° E. was obtained near the bridge over Fifteen-mile Creek. A few yards west of the creek the dip is 70° E., and further west the strata are more and more influenced by the Pratt Valley folds.

Along Fifteenmile Creek, as well as along the county road which runs nearly parallel with it, good exposures are frequent. West from the axis, which is in the center of the Town Hill Gap, the strata gradually become more steeply inclined until at the top of Green Ridge, where the creek road enters the ridge road, the dip is 40° E. Two miles south of this point attitudes of 50° to 54° were found on the western slope of the ridge. East of the axis the dip of the strata is more complex. Within three-fourths of a mile from the center of the gap the dip changes from zero to 44° W. Between this point and the Hampshire-Jennings contact further east, two secondary anticlines appear. As a result of these the dip changes from 44° W. to 55° E., then to 35° W. and again to 32° E., the latter dip indicating the position of the strata near the Hampshire-Jennings contact. A few rods east of this contact line the dip is 38° E., after which the influence of the synclinal axis ceases to be felt.

Near the southern end of Town Hill various observations were made which compare favorably with measurements obtained further north. On the Okonoko-Orleans road one and one-half miles north of the southern limit of the Pocono a dip of 56° W. was observed. Three-fourths of a mile south and a few rods west of this exposure a dip of 49° W. is shown. One hundred and twenty-five yards further west the dip is 21° W. Along the county road leading from Town Hill to Green Ridge there are various exposures. One in the bed of the ravine shows a dip of 61° E., and a few rods further west a dip of 49° E. was seen. This quickly decreases to 38° E., but at the top of Green Ridge the strata dip 52° E. Continuing northwestward

down to and along Town Creek the dip is generally quite steep, being much of the time considerably more than 50° E. and in several places 90° .

THE STRATFORD RIDGE ANTICLINE.

This anticline clearly asserts itself in the two Oriskany exposures east and northeast of Oldtown, and a good exposure locates the position of the axis. About one mile east of Oldtown on the canal near the water level, the dip on the west side of the axis is 30° W. The strata here are bent into a nearly symmetrical arch almost one hundred feet high, although on the east side near the canal level the strata quickly become steeper and plunge beneath the surface with a dip of 63° E. In the long narrow strip of Oriskany to the northeast of this the position of the area corresponds to that of the axis of the anticline. Here the rocks of the Oriskany formation being largely free from covering, show the anticlinal nature of the ridge distinctly. Almost at the extreme northern limit of the area where the county road and a small tributary of Town Creek cut across the ridge a dip of 12° was measured on the west side of the axis. Farther east where Town Creek cuts into the eastern side of the Oriskany the strata have an apparent overturned dip, the attitude there being 70° W. This seems to swing back through 90° very soon, as only a few rods further east a good exposure shows a dip of 44° E. Continuing east along the creek toward Green Ridge the strata wherever exposed show a strong dip, but at some places where the rocks are concealed there is an undoubted undulation, this fact being rendered evident by a dip of 70° W., observed near the angle formed by the creek as it turns west-northwestward from Green Ridge. Two miles south of this, where Town Creek makes an abrupt turn to the east, the dip near the Jennings-Romney contact is 53° E. This gradually increases eastward to 62° E., which observation was made where the creek turns southward. Along the West Virginia side of the Potomac, both east and west of the Stratford Ridge axis minor folds are shown, but on the Maryland side the strata are worn down and concealed in such a manner that these minor folds are not very apparent and, indeed, their

influence seems to die out almost immediately after passing across the river into Allegany county. A few yards east of the mouth of the South Branch the dip is 15° E., but this gradually increases without serious interruption to 90° near by, at which attitude the strata remain for much of the distance between the mouth of South Branch and the Jennings-Romney contact. Between this contact and the mouth of Town Creek the dip is about 55° E. Nearly one-half mile west of the main axis a fold of some importance is seen on the West Virginia side, but it is concealed in Maryland. The limbs dip 15° E. and 25° W.

One-half mile south of the north end of the Stratford Ridge area along the county road running parallel to and west of the axis a dip of 21° W. was found. North of this area, where the creek cuts across the Jennings-Romney contact zone, the dip is 65° E. This increases to 81° E. about one-fourth of a mile nearer Green Ridge, but decreases to 22° E. near where the creek turns south parallel to Green Ridge.

The effects brought about in the formation of the Stratford Ridge anticline are no doubt felt considerably further north than the Oriskany area extends, possibly even reaching for a considerable distance north of the creek, but owing to the paucity of exposures the true conditions cannot be made out.

THE OLDTOWN AND PRATT VALLEY FOLDS.

In the extensive area of Romney shales east, west and north of Oldtown the extreme poverty of exposures prevents any precise description of the structural details, but such definite observation as can be made shows that the strata are considerably folded. Whether or not these folds are very persistent or important in any way is not known. As a consequence, therefore, the structure sections for this part of the county have been made upon data that is necessarily somewhat conjectural, but the general condition of the strata is evidently that of gentle and frequent undulation and they have been so represented.

Pratt Valley may be roughly considered as including the compara-

tively low area lying between Polish Mountain and Green Ridge north of the lower course of Town Creek. With the exception of the exposures along the National Road the conditions for studying the exact features of the structure in this area are even more meagre than in the Oldtown area. The valley is very densely wooded, and over a considerable portion of the area the only means of gaining any knowledge of the underlying formation is to examine the loose shales lying in the cavities left by uprooted trees. On the National Road three hundred yards east of Pratt post-office a beautiful, almost symmetrical, anticline is seen. The west limb dips 40° W. and the east limb dips 44° E. For nearly one-half mile west of this the dip gradually decreases, finally reaching as low as 6° W. at a point about four hundred yards west of Pratt post-office. West of this point the dip increases more and more under the influence of the Polish Mountain syncline. About one-third of a mile east of the axis an exposure shows the strata dipping 30° E., but two hundred and fifty yards further east they dip 85° W. Beyond this for nearly a mile the strata are concealed. When next seen the dip is to the east. South of the National Road no distinct traces of these anticlines can be found, although various measurements on Town Creek and northward on some of its branches indicate much variation of dip with the probable presence of several folds.

At a point two miles west of Pratt two anticlines near each other are poorly shown on the National Road. Their limbs, so far as can be observed, dip nearly symmetrically at 30° to 40° . At a point almost one-half mile west of this the dip is 45° E., but three hundred yards further west the dip has decreased to 35° E. East of the two anticlines, which in fact may be considered as flexures of one main anticline, the dip changes rapidly until Fifteenmile Creek is reached. Starting with a dip of 30° E. the dip undulates through 90° , 50° E., 40° E., 87° W., 35° W., 70° E., 50° E., 45° E., the last measurement being one hundred fifty yards west of Fifteenmile Creek. The dip of 35° W. and 70° E. shows a crumpled anticline about five hundred yards west of the creek. We thus have at least three separate and distinct positions along the National Road in Pratt Valley where anticlines are developed.

By comparing this valley with the corresponding area north of the state line in Pennsylvania, it will be observed that the positions of the Pratt Valley anticlines correspond quite closely to the positions of important anticlines in Bedford county as worked out by the Second Geological Survey of Pennsylvania.¹ Beginning with the easternmost, these anticlines are known as the Broad Top anticline, the Snyders Ridge anticline and the Shavers Creek anticline. In the absence of opposing evidence it seems, with the information at hand, that we may say without probability of serious error that the above-named anticlines as traced out in Pennsylvania extend into Maryland and, crossing the National Road at or near the points suggested, continue an indefinite distance southward, being apparently seriously deflected and possibly entirely dissipated by other more or less important folds before reaching the Potomac river.

THE POLISH MOUNTAIN SYNCLINE.

This syncline follows the trend of Polish Mountain and is the gradually shallowing prolongation of the much more prominent Clearsville syncline of Pennsylvania. On the National Road the dip on the east side of the synclinal axis approximates 20° W., while on the west side it is about 40° E. On the Williams Road, about two miles south of the National Road, the strata on the east side of the syncline are concealed; but on the west side between Town Creek and the crest of the mountain the dip varies from 22° E. to 30° E. Near the south end of the mountain various observations were made, but only those on the western side of the axis are trustworthy. They indicate the average dip to be very nearly the same as that shown on the Williams Road. Further south the syncline becomes lost amidst the confusion of other folds. No rocks higher than those of the Jennings formation are contained within this syncline in Alleghany county. Along the top of the mountain a heavy conglomerate is shown south of the Williams Road, but where the mountain is crossed by the National Road the conglomerate has apparently been

¹Stevenson, J. J. Geology of Bedford and Fulton Counties, Report T2, Second Geological Survey of Pennsylvania, Harrisburg, 1882.

worn completely away, although its former position is shown by a few scattering but much weathered boulders. This conglomerate capping is apparently the same as the heavy conglomerate seen in many other places in the county near the top of the Jennings, and in Pennsylvania where the opportunities for studying the rocks of this syncline are better than in Maryland, the Pennsylvania Geological Survey has similarly located it and has correlated it with the Chemung Upper Conglomerate.¹

THE TUSSEY MOUNTAIN ANTICLINE.

Within that structural division of the Appalachian system of which Allegany county forms a part, the folds of predominating importance are usually those long antilines which are of sufficient magnitude to bring up the Silurian rocks. Of such antilines Allegany county has three that are well developed. All of these enter the county from Pennsylvania, but in each case the position of the anticline becomes entirely obliterated or very much disturbed before reaching the Potomac river. The Tussey Mountain anticline is the easternmost and most quickly obliterated one and at the state line occupies the position of Tussey Mountain. Continuing nearly southward across the National Road and then more nearly southwest the anticline bifurcates, one branch following the direction of Warrior Mountain, the other that of Martin Mountain.

Near the state line where the Tuscarora of Tussey Mountain is cut through by Flintstone Creek the dip on the west side of the anticline is 18° W. Although not well known, it is apparently about the same on the east side. Further east the strata where not concealed show a varying dip, the Clinton being much folded there. Along Flintstone Creek northward from Flintstone for half a mile or more the general dip is 40° to 50° E. One and one-half miles west of Flintstone Creek on the National Road a dip of 40° E. is shown. One-half mile further west the dip is 5° W., the intervening area apparently representing the position of the main anticline. Further west, as far

¹Stevenson, J. J. Geology of Bedford and Fulton Counties, Report T2, p. 31, Second Geological Survey of Pennsylvania, Harrisburg, 1882.

as the abandoned limekiln in the Helderberg formation, three miles west of Flintstone, the dip varies from 20° to 30° W., but the exposures are not good. Along a small ravine, about one mile south of the National Road and running nearly parallel with it, various measurements indicate the general attitude of the strata to be much the same as along the National Road. However, further east along the Murley Branch road considerable confusion of dip exists and this is found to be due to the presence of a minor fold running parallel with Murley Branch. The exact position of the axis of this minor fold is best seen a little more than half a mile east of Rush on the Williams Road. A few feet of the red sandstone near the bottom of the Salina is there shown in a small anticline whose limbs have a dip of 15° . The same anticline with a similar exposure of Salina is brought to view on the ravine two hundred yards south of this. It cannot be traced further south. The anticline is not well shown northward from the Williams Road, but its presence is sufficiently indicated to enable one to trace it for a distance of more than two miles. The Tussey anticline bifurcates in the vicinity of Rush, and the Murley Branch fold is no doubt one expression of the beginning of bifurcation.

On the county road leading west-northwest from Rush, various outcrops indicate a much disturbed condition of the strata. At least four anticlinal flexures cross the road within a mile of Rush. The positions of the axes of these folds cannot be actually seen, but their presence is sufficiently indicated by various exposures along the road. The dip at Rush near the iron bridge over Murley Branch is 55° to 75° E.

In the double southern extensions of the Tussey anticline but few measurements of the attitude of the strata can be obtained. The Warrior Mountain branch can be easily traced to within a mile of the Potomac. Along the eastern side on the county road running near the Oriskany-Romney contact the dip varied but slightly, 27° E. being the greatest dip observed and 17° E. the lowest. The dip along the western side is much the same.

In the vicinity of Twiggstown the western projection of the Tussey

Mountain anticline in turn becomes bifurcated, the western projection of this bifurcation forming the Collier Mountain anticline with east and west dips of about 40° .

THE MARTIN MOUNTAIN AND COLLIER MOUNTAIN ANTICLINES.

The Martin Mountain anticline occupies the position of that mountain and has been formed by a bifurcation of the larger anticline south of Rush Ridge. The dip varies from 35° to 50° , the two limbs having approximately the same inclination. Near the Potomac the dip is less, scarcely reaching 25° on either side.

THE BIG SPRING RUN SYNCLINE.

This syncline, which is formed by the gradually separating branches of the Tussey Mountain anticline, occupies the triangular Romney area west of the southern end of Warrior Mountain and includes within it a considerable portion of the valley of Big Spring Run. The rocks are almost wholly concealed, but along the Potomac river the observations indicate that the strata are considerably, although not deeply, plicated.

THE MARTIN SPRING BRANCH SYNCLINE.

This is a narrow syncline lying between Martin Mountain and Collier Mountain, and extends from the Potomac river northward to within about two miles of Twiggstown. It occupies the position of the long narrow Romney area in which Martin Spring Branch lies, and is in general appearance much like the Collier Run syncline which lies to the west of Collier Mountain. The dip on either side varies between 20° and 45° .

THE COLLIER RUN SYNCLINE.

Collier Run syncline stretches across the county in a general north-east-southwest direction. In its southern and middle portions it is flanked by Collier Mountain and Nicholas Mountain and is marked by a long narrow strip of Romney shales within which Collier Run lies. Near the headwaters of Collier Run, Nicholas Mountain and Martin Mountain gradually coalesce and become one synclinal ridge.

Nicholas Mountain losing its identity and its name. Martin Mountain, still capped by Oriskany rocks, continues northward beyond the state line.

Along Collier Run the dip of the syncline on either side is steep and seldom less than 30° near the Romney-Oriskany contact. It is generally more than 40° . More varying measurements, as might be expected, were obtained in the Romney exposures, but since the measurements usually express only unimportant local conditions they need not be given here. On the Potomac at the Romney-Oriskany contact on the east side of the syncline the dip is 39° W. At the corresponding point on the western side it is only 20° E., but increases farther west. The synclinal nature of Martin Mountain, where crossed by the National Road, is well indicated by the many measurements obtained, the dip on the east side being from 60° W. to 80° W., while on the western side the dip is much less, it being not more than 35° E.

THE EVITTS MOUNTAIN ANTICLINE.

This anticline enters the county from Pennsylvania and is distinctly marked for a short distance by Evitts Mountain. On the National Road, and for three or four miles further south, it is not well marked topographically, but south of the Williams Road the axis of the anticline gradually takes the position occupied by Nicholas Mountain.

Near the southern end of Evitts Mountain a branch of Evitts Creek has cut deeply across the Tuscarora quartzite and has disclosed to good advantage both limbs of the anticline. On the west side of the Tuscarora-Clinton contact the dip is 54° W. On the eastern side at the corresponding point it is 18° E. On the county road running around the southern end of the mountain a measurement of 50° W. was obtained on the west side and 22° E. on the east side. On the National Road the position of the axis seems to be just east of where the Johnson Road enters the National Road from the south. Immediately at this point of union the dip is 39° W. One hundred yards further west in the outcrop of red sandstone near the bottom of the

Salina the dip is 67° W. Continuing westward the dip in the Helderberg limestone undulates through 54° W., 70° E., and 72° W. Fifty yards east of the Johnson-National road fork the dip is 21° E. Nearly one-half mile further east the Hinckle Road enters the National Road from the south, at which point the dip is 32° E. One-half mile east of this where a county road from the north enters the National Road the dip is 17° E. Still further east, in the lower part of the Salina, the dip is 25° E., but increases shortly to 35° E., then rapidly to 78° E., then decreases to 30° E. near the middle of the Helderberg. East of this the dip gradually increases until near the position of the Collier Run syncline. On the Hinckle Road near the bottom of the Salina the dip is 18 E., gradually increasing south-eastward to 36° near the Romney-Oriskany contact. Three-fourths of a mile south of the National Road on the Johnson Road the dip is 42° E., while further south, near the fork in the road, it is 34° E. East of this for half a mile the prevailing dip is less than 15° . On the Williams Road the anticlinal axis appears to be almost in the bottom of the valley on the western side of Nicholas Mountain. Here a small sharp anticline is exposed. East of this anticline, as far as Collier Run, all of the outcrops show an easterly dip of the strata, the dip varying from 7° to 34° . West of the anticline, as far as Evitts Creek, all of the outcrops show a westerly dip of the strata, the dip varying from 50° to 72° . Along the Potomac river the dip on the eastern side of the axis varies from 20° E. to 42° E., while on the western side the range of dip is from 15° W. to 54° W.

THE EVITTS CREEK SYNCLINE.

The Evitts Creek valley, together with the low-lying West Virginia and Maryland areas to the south, practically includes all of the Evitts Creek syncline. It is bounded on the east by a row of Oriskany hills which extend from the state line southward to near the Potomac river, where the hills become gradually absorbed by Nicholas Mountain. Shriver Ridge, in Maryland, and Knobly Mountain, in West Virginia, both protected by Oriskany sandstone, lie along the western side.

In that part of the syncline which lies north of the Potomac river outcrops are frequent. Along the National Road, and along the Baltimore and Ohio Railroad, this is particularly true. In addition to these a county road about one mile south of the National Road discloses the attitude of the strata in many places, and on the eastern side of the syncline along the Williams Road a good series of exposures is also shown. In addition to these, many other more scattering and less easily located exposures were found. With but rare exception these exposures all show that the axis of the syncline is thrown far toward the eastern part of the valley, as is also Evitts Creek in much of its course. North of the National Road and west of Evitts Creek the dip is to the east in every place observed and in some instances the easterly dip continues a considerable distance east of the creek. Along the eastern side of Shriver Ridge the dip is 30° E. to 35° E., although about one and one-half miles south of the state line a measurement of 44° E. was obtained. One mile south of the state line on Evitts Creek the strata stand upright, as they were observed to do also two miles south of the state line. On the National Road about one-half mile east of the creek the dip is also 90° , but this may be a very local feature, since between this point and Evitts Creek there are two anticlines. Where Evitts Creek crosses the National Road the dip is 27° W. East of Evitts Creek on the Williams Road at the Jennings-Romney contact the dip is 70° W. Continuing eastward the dip varies through 50° , 65° , 72° , and 59° , the last measurement having been obtained near the Romney-Oriskany contact. Going south from Cumberland, then east along the Baltimore and Ohio Railroad, the dip, with insignificant exceptions, remains from 15° E. to 20° E. until within about one-fourth of a mile of the mouth of Evitts Creek, where a small amount of folding is observed. Just west of the creek the dip is 16° E., but the only observations in this locality east of the creek show a considerable dip to the west. In view of these facts it seems quite evident that the main axis of the syncline crosses the Potomac river at or near the point where Evitts Creek enters it.

In that part of the syncline which is occupied by the large west-

wardly projecting area west of the southern end of Nicholas Mountain no good outcrops were seen, the surface there being almost wholly covered by river-washed materials.

THE WILLS MOUNTAIN ANTICLINE.

This anticline, like the Evitts Mountain and Tussey Mountain anticlines, is distinctly marked by a ridge of Tuscarora quartzite. It enters Allegany county from the north and continues in an approximate S. 30° W. direction as a prominent topographic feature for a distance of more than ten miles. The eastern limb of the anticline has a moderate dip. The west limb dips steeply. Near the Tuscarora-Clinton contact line along the east side the prevailing dip is less than 30° and shows but very little variation, while along the corresponding contact line on the west the dip approaches and sometimes exceeds 70° .

The structure of the mountain is most admirably shown in the Wills Creek gorge known as "The Narrows," where, acting like a veritable saw and keeping pace with the gradually rising strata, the creek has cut for itself a narrow passage across the mountain and has thus disclosed on either side a rocky arch of magnificent proportions. Here immense talus slopes extending upward more than five hundred feet, are overhung by high precipitous walls of massive white quartzite. Toward the east end of the gorge, where the talus is less prominent, the strata may be seen to descend slowly, the dip increasing to 24° E. at the Tuscarora-Clinton contact. At the western end of the gorge the dip is precipitous, the well-exposed Tuscarora strata there plunging beneath the surface with a dip of 72° W.

South of the National Road, Wills Mountain becomes gradually deflected from its general course of S. 30° W., and for some distance before reaching Cresap runs nearly due south. At Cresap the Tuscarora passes beneath the surface, and with its disappearance the mountain becomes obliterated.

As a result of the eastward deflection of the southern end of Wills Mountain, some minor folding has been brought about along the Potomac river southeast of Cresap, where the upper beds of the Tus-



DANS ROCK, SHOWING POTTSVILLE CONGLOMERATE.

carora are raised to the surface in two sharp anticlines. One of these anticlines has exposed almost one hundred feet of the Tuscarora and can be traced for nearly five hundred yards in a general south-south-west direction. The smaller anticline which lies a short distance southeast of this is not sufficiently individualized to be distinctly traced longitudinally and is scarcely more than sufficiently prominent to bring the Tuscarora to the surface.

In the northern part of the county east of the Tuscarora-Clinton contact line east of Wills Mountain the dip increases slightly but rarely reaches more than 40° E. West of the axis the dip in the Clinton wherever exposed is great. Further west in the Helderberg and Oriskany formations several excellent exposures give a prevailing dip of 90° . This is admirably shown at the "Devil's Backbone" near Corriganville, as well as at either end of the low elongated hill lying just west of the "Narrows."

Near the state line, a short distance west of the long narrow Oriskany area there is a slight fold which in some low places brings the Oriskany to the surface again. Immediately west of this the dip is steep, but continuing westward it gradually grows more nearly horizontal.

South of Braddock Run the high pitch of the strata is fully as prominent as further north and the excellent exposure at Potomac Station shows the strata in much the same attitude as at the "Devil's Backbone."

THE RAWLINGS SYNCLINE.

By the Rawlings syncline is designated that small, poorly defined structural region which lies to the north and east of Rawlings and which is marked by a southward projection of the Romney formation across the Potomac river into West Virginia. The upright strata of the Oriskany and the Helderberg may be considered as occupying the eastern side, while on the west the limits are poorly defined except near Rawlings, where the rather steeply dipping Oriskany strata are well shown. Good exposures are almost wholly lacking, but a study of the areal geology in connection with the topogra-

phy leads at once to correct conclusions as to the general synclinal nature of the fold.

THE FORT HILL ANTICLINE.

The high isolated Oriskany-Helderberg hill extending southward from Rawlings for a distance of more than four miles is a rapidly disappearing remnant of the Fort Hill anticline which extends from Rawlings to Keyser, West Virginia. The anticline has been much obscured by the corrosive action of the Potomac river and much of it now lies on the West Virginia side. Along the western side the prevailing dip of the Oriskany strata is from 70° W. to 90° W., although south of Monster Rock, in an exposure near the West Virginia Central Railroad bridge, an overturned dip of 65° E. may be clearly seen. Near Rawlings, where the Oriskany passes beneath the surface, the west limb dips 28° W., while a little further south the east limb dips 42° E. At Monster Rock the anticline is quite narrow and near Rawlings it comes to a point. Midway between the two the width is considerably more than a mile.

In the projecting area occupied by Monster Rock the east limb of the anticline is seen to dip gently to the east for a short distance, but before passing beyond the river the strata rise again with a dip to the west. The little syncline thus produced is worthy of notice, as it is apparently the prolongation of the Rawlings syncline which, passing along down the western side of Knobly Mountain in West Virginia, re-enters Allegany county near Monster Rock as indicated.

THE GEORGES CREEK SYNCLINE.

The Frostburg syncline is defined on the east by the Wills Mountain and Foot Hill antilines already described. The western limit is west of Savage Mountain beyond the borders of Allegany county, hence need not receive further mention here. The full width of this syncline, of which only the eastern and central portions lie in Allegany county, remains approximately ten miles throughout its entire course across the state. This measurement, however, is not to be confused with the width of the high valley lying between Savage

Mountain and Dans-Little Allegheny Mountain which occupies scarcely more than one-half of the synclinal fold. The axis of the syncline has been designated with considerable detail by means of the various mining operations in the coal basin. Its general direction is N. 28° to 30° E. passing through Franklin, Barton, Moscow and Lonaconing. It lies a little to the west of Westernport and passes through the immediate vicinity of Mount Savage.

Steeply-dipping Silurian and Devonian strata occupy the eastern border of the syncline, but gradually growing less steep westward from Wills Mountain they disappear one by one beneath the high-lying Carboniferous strata of the coal basin.

In the gap through which Jennings Run flows, where many of the strata, particularly those of the Hampshire formation, have an excellent exposure, the gradually decreasing inclination of the beds may be clearly seen. Numerous good exposures further south along Braddock Run and still further south in the Potomac gorge also aid materially in arriving at correct conclusions concerning the structure of this part of the county.

At the Jennings-Hampshire contact in the Jennings Run gap the dip is 68° W. At the Hampshire-Pocono contact the dip has gradually decreased to 28° W. At the Pocono-Greenbrier contact it is 17° W., while at the Mauch Chunk-Pottsville contact the dip is only 13° W. Further west the dip continues to gradually grow less.

In the Potomac gorge and along Braddock Run the favorable places for observation cannot be concisely described but the measurements obtained correspond closely to those made along Jennings Run.

These measurements were all obtained near the level of the streams mentioned, hence following the various formations upward to the positions which they occupy in the higher parts of the Alleghany Front the dip is found to increase slightly. Opportunities are not good for learning definitely how much this increase is, but it is known that the Pottsville dips from 16° W. to 22° W. where best exposed along the high crest of Dans-Little Allegheny Mountain.

Outcrops of strata in Allegany county suitable for accurate measurement of the dip are rare west of the synclinal axis. Southward

from the state line the Allegany-Garrett line gradually approaches the position of the synclinal axis, hence the western limb of the syncline is but poorly represented in Allegany county. It seems, however, that the steepness increases somewhat less rapidly west of the axis and the prevailing dip of the Pottsville in the northwest corner of the county is thought to be not greater than 12° E. to 15° E.

DIP, STRIKE, AND PITCH.

Certain facts of prime importance in the study of Appalachian structure which have abundant illustration in Allegany county and which have been brought out to some extent in the description of the individual folds demand particular mention. These relate to dip, strike, and pitch. It was observed that the three principal anticlines in the county, viz., the Tussey Mountain anticline, the Evitts Mountain anticline and the Wills Mountain anticline all have moderate easterly dips. The same is not true, however, of their westerly dips. The west limb of the Tussey Mountain anticline, so far as is shown in Allegany county, happens to have apparently about the same dip as the east limb, but the west limb of the Evitts Mountain anticline has a dip more than twice as great as the east limb, while the dip of the west limb of the Wills Mountain anticline is almost three times as great as the dip of the east limb. A similar condition is observed to prevail in connection with many of the less important folds, hence we may say that the Allegany county anticlines tend to develop limbs sloping gently to the east and steeply to the west. Expressed in terms of synclines, we may say that the synclines tend to develop steeply-sloping limbs on the east side of their axes and gently-sloping limbs on the west side. These facts are in accord with observations made throughout almost the entire Appalachian region, and it is upon these facts that many able geologists have based the theory that the deforming force which produced these folds came from the southeast. These facts alone seem inadequate to prove the truth of the theory, but that the initial force did really originate in that direction has been pretty generally accepted by geologists.

The strike of the beds, as in most other parts of the Appalachian

region, varies within rather narrow limits. The Tussey Mountain anticline and the Evitts Mountain anticline extend approximately N. 27° E., while the Town Hill syncline, the Collier Run syncline, the Wills Mountain anticline, and the Georges Creek syncline all have a direction approximately N. 30° E. Observations in many other places show that in no case worthy of special note do the beds lie at great variance to the general direction given.

Nearly all of the folds show more or less axial pitch and this pitch is downward to the south almost without exception. The exact nature of this pitch along many of the folds cannot be easily computed, but from field observations on the major anticlines it seems that even in extreme cases the pitch scarcely reaches five degrees. It is to this pitching of the folds that much of the characteristic structure of the Appalachian Region is due. The effect of the pitch on the areal distribution of the formations is best illustrated in Allegany county by the Evitts Mountain anticline. At the state line on the north the axis of this anticline is indicated by the tongue-shaped area of Tuscarora quartzite. Southward the Tuscarora narrows and disappears beneath the later Clinton formation. The Clinton continuing southward upon the axis also narrows and disappears beneath the succeeding Niagara formation. This in like manner is followed in regular order by the Salina, the Helderberg and the Oriskany. The pitch in the southern part of the county is slight, as is evidenced by the emergence of the Helderberg again where the Potomac has cut across Nicholas Mountain. Similar areal distribution of formations brought about by pitching of the folds may be observed in almost every fold west of Town Hill. In much of the Georges Creek syncline this is not quite so apparent, but in the northern part of the county the upward pitch to the north becomes perceptible, and as a result the coal measures all come to the surface within some fifteen miles north of the state line.

FAULTS.

Faulting is rare and the amount of vertical movement is never great. Only the more thinly bedded strata present instances of faulting

worthy of note, and none of the observed faults have more than a local extent.

In the Jennings formation along the Williams Road on the hillside near the eastern edge of Cumberland there is a fault whose throw seems to be considerable, but no definite idea as to the exact amount of displacement could be gained.

On the Baltimore and Ohio Railroad west of Cedar Cliff, about three miles south of Cumberland, a small, clearly faulted anticline is seen in the red shaly sandstone bands near the bottom of the Salina formation. The throw here is only a few feet.

Other faults occur, but so far as observed they are of no special moment except in the general relation which they bear to the more important structural features of the region.

STRUCTURE SECTIONS.

On the structure-section sheet (Plate XVI) twelve structure sections are given. They represent the strata as they would appear along the sides of trenches cut across the county on the section lines and extending downward to the position of sea-level. All of the sections extend in the direction N. 60° W., S. 60° E. which is approximately perpendicular to the prevailing strike. The relative positions of the various section lines have been chosen with especial reference to lines along which most favorable conditions for field observations were found, combined wherever possible without sacrificing accuracy with such positions as best reveal the various structural changes. For this reason the distances between the section lines vary. Those crossing the eastern and central portions of the county are approximately two miles apart, while the distances between those lying wholly within the western part of the county average about four miles.

On the structure-section sheet the straight line at the upper edge of each blank space represents the section-line along or near which the field observations were made; the straight line on which the section rests indicates the position of sea-level; while the undulating line at the top represents the surface configuration along the section-line.

INTERPRETATION OF THE SEDIMENTARY RECORD.

GENERAL CHARACTER AND VARIATION OF SEDIMENTS.

The three chief topographic phases of sedimentation indicated by sandstones, shales and limestones are well represented in Allegany county. Reviewing briefly that which has been given in detail in earlier pages, we find that four formations, the Tuscarora, the Oriskany, the Pocono and the Pottsville, are entirely or largely composed of heavy sandstones; that nearly the whole of the Helderberg and the Niagara, as well as much of the Salina and the Greenbrier are made up of limestones; and that all of the other Paleozoic formations consist more or less completely of soft shales and thin-bedded limestones and sandstones.

Marked changes in the character of the formations as they extend across the county are observed in only a few instances. The Oriskany and the Jennings thicken considerably toward the west, the Greenbrier thickens to the south and the Pocono apparently thickens to the north. Lithologically the Pocono on Town Hill differs materially from the Pocono in the western part of the county. In the east it is very massive and coarsely conglomeritic wherever observed, while in the western portion it is much less massive and is free from heavy conglomerate. The other formations do not change except in minor particulars, and as these changes have been mentioned elsewhere they need not be repeated here.

THE EARLY PALEOZOIC PERIOD.¹

In early Cambrian time a long strait extending from the region of the Gulf of St. Lawrence southward to Alabama occupied approximately the position now occupied by the greater Appalachian valley. It separated a mountainous Archean continent known as Appalachia from a comparatively low-lying land area covering the Central States region. During Cambrian time erosion greatly reduced the height

¹ For the discussion of this period as well as for much that follows the author has drawn liberally from the writings of others, especially of the members of the Appalachian division of the United States Geological Survey and of the State Geological Surveys of Pennsylvania and New York.

of the Archean continent and the detritus thus obtained was deposited to the westward while the sea gradually transgressed eastward. Near the close of the Cambrian period the western land area began to sink and the strait gradually widening westward to Wisconsin and beyond the Mississippi formed a great mediterranean sea. Conditions were then poorly suited for the transfer of land-derived sediments, and a long period of limestone deposition set in. In course of time a disturbance of conditions took place and the limestone deposition gave way to a widespread distribution of shale. The deposition of this shale, besides indicating an uplift of the eastern land from which the sediments were derived, marks also a recession of the shore line and a probable shallowing of the sea. This shale, known in Maryland as the Martinsburg formation, was followed by a series of reddish shales and sandstones—the Juniata formation in Maryland—the upper part of which is exposed in Allegany county. With the history of this formation the immediate geological history of Allegany county begins. As shown on a previous page, the sandstones of the Juniata multiply and thicken toward the top and thus indicate a steady approach to conditions of shallow water deposition.

THE TUSCARORA PERIOD.

With the advent of the Tuscarora period a decided change in the factors of decomposition was introduced. The lithologic characters of this formation, which have been described on a previous page, indicate that the sediments were laid down in shallow water. However, to say that the Tuscarora formation is a product of shallow water deposition is only a meagre introduction to the explanation of the conditions involved. Dr. A. C. Spenceer, in his paper on "The Geology of Massanutten Mountain in Virginia," has given a clear summary of the probable factors which operate to bring about such concentration and deposition of materials, and has discussed these factors in the light of sediments in the Massanutten area similar to the Tuscarora of Maryland. He says "The concentration of the more resistant products of rock-decay for the formation of extensive sandstones is a process of great complexity. During the early part of a

topographic cycle when denudation exceeds decomposition, the numerous rapid streams deliver to the sea large quantities of coarse materials of mixed composition which may be partially sorted by the waves and somewhat widely distributed by marine currents; but as drainage becomes more mature there will be a tendency for stream-derived detritus to accumulate at the mouths of large rivers, often without much wave-washing. In either case the deposits will be more or less heterogeneous, and the same will be true of the deposits derived by a transgressing sea from a land surface covered by a deep residual mantle. Such coarse-grained heterogeneous deposits would be confined to a rather narrow littoral zone, but brought a second time under the action of the waves by a slight elevation of the land, they would be re-sorted, the less resistant components would be largely ground up and removed as fine silt and the zone of coarse sediments would be moved seaward. At the same time the rivers might be bringing fresh material, but with continued slow, or intermittent rise of the land accompanied by marine planation, these and the older surviving materials becoming mingled, the final result would be a mass of sand and pebbles composed almost entirely of quartz.”¹

The uniform nature of the quartzite indicates a time of comparative quiescence and but one source of material. The period was perhaps initiated by a gradual but rapid uplift of the land accompanied by a shallowing of the sea which prevailed until the close of the period. As to the position of the shore-line at this time with reference to Allegany county but little is known except that it was in all probability a considerable distance east of the county. Southward in West Virginia and northward in Pennsylvania the formation is considerably thicker and in each of these areas the deposits are inclined to be coarser than in Allegany county, this being particularly true in Pennsylvania. Whether the lesser thickness of the formation in Allegany county is due to local or remote causes is not known. A shallowing of the sea may have deflected the currents or a deepening of the sea may have lessened their power, in either of which cases much of the sediment would have been deposited elsewhere.

¹ Spencer, A. C. The Geology of Massanutten Mountain in Virginia. Washington, 1897.

THE LATER SILURIAN PERIOD.

With the advent of the Clinton, conditions very similar to those immediately preceding the Tuscarora seem for a time to have prevailed. The red shales, with alternating sandstones, were again introduced, but they are more thinly bedded than those of the Juniata. That the Tuscarora represents only temporary invasion of pure quartzose materials which interrupted the deposition of red clays and sands may be possible. The topographic cycle may have advanced sufficiently slowly to allow the waves of marine planation to cut their way across the old littoral deposit and to reach again the region of uncovered crystalline rocks. If detritus was obtained in this way the waves would perhaps be unable to properly sort it but might be able to deliver the lighter materials to strong currents and thereby bring about the distribution as we find it. Whatever may have been the conditions it seems evident that the subsidence soon became sufficiently great to bring about decidedly new conditions. With the deposition of the upper part of the Clinton formation, limestone and iron ore were both introduced, the iron being of comparatively little importance in the Juniata except as a coloring matter, while the limestone is wholly absent.

Concerning the Niagara period, Professor James Hall says that the condition of the ocean seems to have been favorable to the production of corals and crinoids and to the deposition of calcareous beds of magnesian character, the sea being comparatively shallow.¹ In Allegany county the calcareous beds have been in part replaced by argillaceous sediments apparently indicating occasional changes in marine currents at this time. The corals and crinoids were acted upon with considerable energy by the waves, as is indicated by the immense quantity of broken and worn fragments thrown heterogeneously together and cemented by the calcareous mud produced by a more complete trituration of some of the materials.

These finely comminuted deposits, profusely filled with fragments of organic remains uniformly deposited over wide areas, show an un-

¹ Twenty-eighth Annual Report of the New York State Museum of Natural History. The Fauna of the Niagara Group. Albany, 1879, p. 101.

disturbed transition upward, and the abundance of carbonate of lime coming into the sea and entering into the secretions of the various marine organisms indicates the presence of much calcareous material easy of access. The Silurian limestone was evidently the source of this material, as it had no doubt been raised above the level of the sea in various places and thus brought under the influence of aerial degradation.

The lower portions of the Salina add further proof of the shallow water conditions. The red sandstone of that formation, with its salt, gypsum and fish remains, as found further north, was certainly laid down in reasonably shallow water and in all probability in more or less land-locked bays. At any rate, although no very great structural disturbance appears to have taken place at this time, the conditions affecting marine life appear to have been very greatly changed. In Allegany county no fossils have been found in the red sandstone and the presence of salt and gypsum has not been proven, but the conditions of deposition are believed to have been much the same as further north. Whatever may have been the condition, it is evident that when the Helderberg period was initiated the organic life which came with it was very unlike that which prevailed during the time immediately preceding the shaly sandstone deposition.¹

THE HELDERBERG PERIOD.

From the general character of the Helderberg fossils it would seem that the depth of the water at this time was perhaps not far different from that of much of the later Silurian period, but one thing of especial note is the almost entire absence in the Helderberg of mechanical detritus, such as sand and clay. Apparently the surface configuration of the land was very subdued. Possibly conditions of base-level erosion now prevailed such as had existed during Lower Silurian time. If such were the case the streams, being weak, would be unable to transport the heavier detritus in suspension, but might continue to carry much calcareous matter in solution. The adjacent

¹ Clarke, J. M. The Hercynian Question. Forty-second Annual Report of the Trustees of the State Museum of Natural History. Albany, 1889, p. 436.

seas then being free from muddy sediments but highly charged with carbonate of lime would be in favorable condition for the growth of animal organisms such as the Helderberg contains, and extensive limestone beds would be formed from the detritus produced by them.

THE ORISKANY PERIOD.

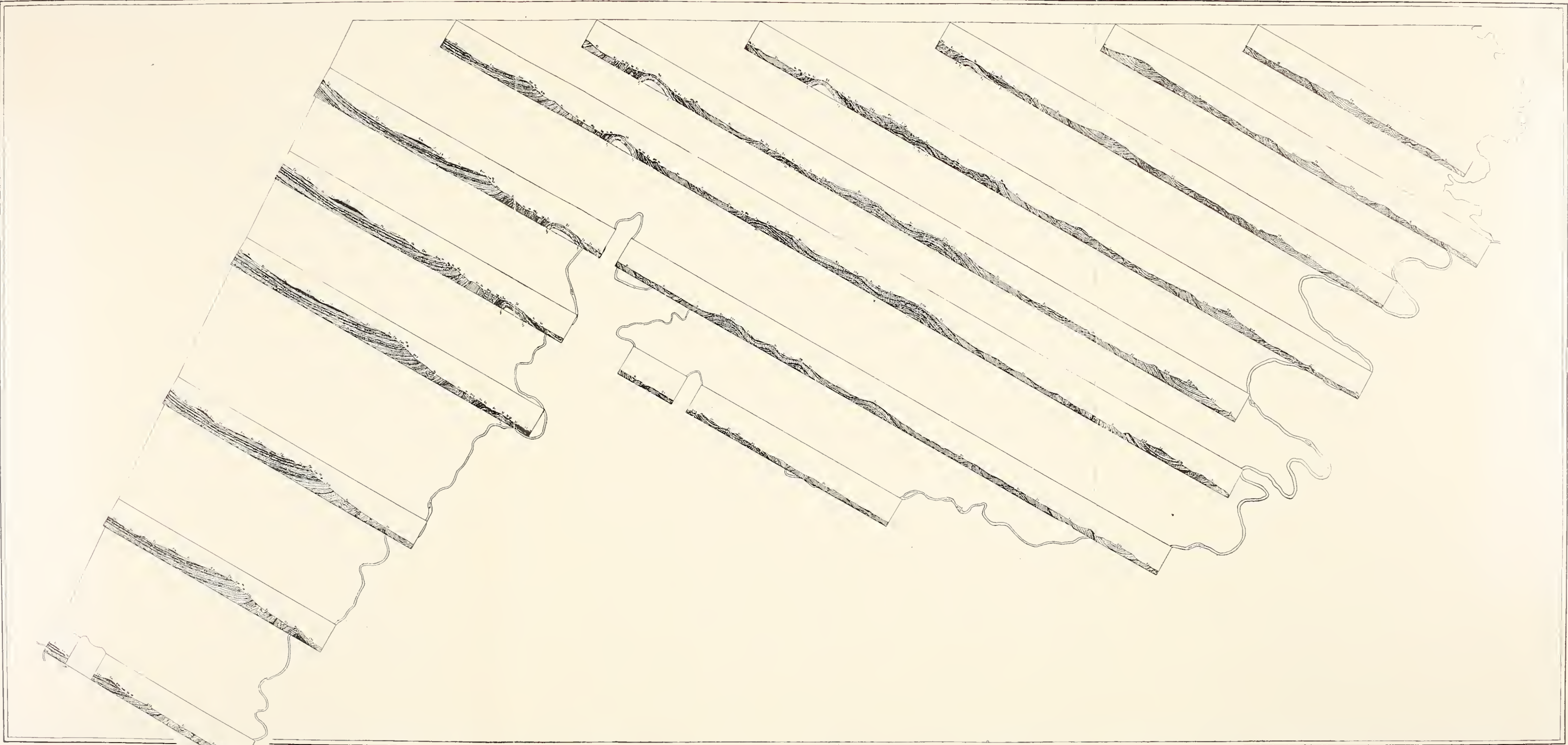
With the advent of the Oriskany a great change in the character of the sediments again took place. As has been stated elsewhere, the formation is made up of highly fossiliferous sandstones and conglomerates separated from the Helderberg proper by a transition zone of interbedded limestone. We have already seen how the coarse quartzitic detritus which contributed the sands of the Tuscarora may have been gradually stored up on a pre-Tuscaroran Coastal Plain. The events in the concentration of materials to supply the sands and pebbles of the Oriskany were perhaps much the same. As in the case of the Tuscarora, an upward earth-movement evidently initiated the principal factors of final distribution. Simultaneous with this the shallowness of the sea became sufficiently accentuated to admit of the currents acting with much energy, thereby enabling them to transport heavy materials for considerable distances.

The supply of carbonate of lime continued throughout the period in sufficient abundance to admit of prolific marine life. In many places the formation is a mass of shells and casts and the abundant cementing material is often so prominently calcareous that a perfectly fresh specimen has much the appearance of a true limestone.

THE DEVONIAN SHALE PERIOD.

The Romney, Jennings and Hampshire formations are largely composed of fine sediments, and may here be treated together. According to Mr. Willis, the lowlands of the early Devonian were general from New York to Georgia, continuing low in the southern Appalachian area throughout the Devonian, but northward becoming considerably elevated, produced mountains probably several thousand feet high, the degradation of which supplied the later Devonian sediments.¹ Near the close of the Oriskany period the area covered

¹ Piedmont Folio, U. S. Geol. Survey, 1896.



STRUCTURAL SECTIONS IN ALLEGANY COUNTY.

by Allegany county seems to have been elevated and possibly to a sufficient extent to allow of some erosion, although this is not proven. However, in Virginia and Pennsylvania, local non-conformities exist between the Oriskany and the Romney, and it seems probable that the changes in Allegany county were in harmony with the movements which brought about the non-conformities to the north and south. The lower shales, resting with sharp contrast upon the Oriskany, are extremely fine and highly carboniferous. Various hypotheses have been given to explain the manner of deposition of these fine sediments. It would seem that a gentle subsidence after emergence might so affect the currents that, sweeping swiftly over the arenaceous beds they might thoroughly wash away any superficial coating which may have previously collected there. The land surface was no doubt low, and thus for a long time not in a condition to supply coarse detritus. H. D. Rogers, in his admirable paper on the origin of the Appalachian strata, long ago suggested that these black sediments possibly accumulated in a very widely spread sea marsh or marine savannah, the carboniferous part of the shales being the result of plant growth.¹

The argillaceous portions evidently came from a low-lying land surface. During the removal of the heterogeneous Coastal Plain detritus which furnished the materials for much of the Oriskany formation, the land surface farther inland was low and unaffected by rapid streams and gradually became covered with a coating of chemically disintegrated materials awaiting future transportation. Disturbances which we know occurred near the close of the Oriskany period may have easily brought about conditions favorable for the slow removal of this residual mantle.

A general but perhaps slight depression allowed the deposition of the limestone near the bottom of the Romney, following which shallow water conditions with only minor interruptions continued until after the beginning of the Carboniferous time.

¹ Rogers, H. D. *The Geology of Pennsylvania*, vol. ii, p. 791. Philadelphia, 1858.

THE LOWER CARBONIFEROUS PERIOD.

In Allegany county there is little apparent difference between the highest Devonian and the lowest Carboniferous sediments except in color and coarseness. In each case the sediments are almost wholly of quartzose materials and indicate shallow water and mountainous land conditions. Cross-bedding, ripple-marks and thin coal seams all attest a preparatory step toward the marshy condition of the Coal Measures.

The limestones and shales following the Pocono formation indicate a degradation of the Devonian mountains and an almost unvarying relation of land and sea. That the land appeared above the surface, however, in places not far from the Allegany county area seems proven by the bands of limestone-shale breccia at the Greenbrier-Mauch Chunk and the Mauch Chunk-Pottsville contacts.

THE COAL MEASURES PERIOD.

Following the limestones and shales of the lower Carboniferous period massive conglomerates, sandstones, shales, limestones, coals, fire-clays, etc., were laid down in rapid but irregular succession. The features of this deposition being much the same throughout a large part of the Appalachian region, a detailed discussion of the period need not be entered upon here. The general conditions which prevailed may be stated in the following words: "During middle and later Carboniferous time there ensued that general vertical movement of the eastern land area and the region of the interior sea which resulted in the withdrawal of the sea to the Mississippi embayment. The movement was not simple; it was composed of many episodes of uplift and subsidence, among which uplift preponderated. In the repeated oscillations of level the sea swept backward and forth over wide areas. It received from the Coastal Plain the coarse quartz detritus which had accumulated during previous ages, and the waves and currents of the shallow sea spread the concentrated sandstones and pebbles in beds which alternated with materials of less ancient derivation. The Carboniferous strata include shale and sandy shale, derived more or less directly from lands of moderate elevation, and

also the coal beds, each of which marks the prolonged existence of a marsh in which the peat-making plants grew. When the marsh sank beneath the sea the peat beds were buried beneath sands and shales, and the peat, by a process of distillation, became coal.”¹

SUBSEQUENT HISTORY.

In the review of the sedimentary record we have seen how elevation and subsidence followed each other with varying rapidity while the large volume of Paleozoic sediments was being deposited. It seems probable that during this time some lateral pressure was also exerted upon these sediments, producing incipient anticlines and synclines. It was not, however, until near the close of Paleozoic time that structural changes of exceptional magnitude were manifested throughout the entire Appalachian province. The strata which had been deposited upon each other in an approximately horizontal position were then squeezed and folded to an enormous degree, the forces being applied laterally in a direction perpendicular to the course of the present mountain ranges. How long this compression continued is not known. Suffice it to say that the earliest Mesozoic records show a new axis of drainage and that most of the rivers, instead of flowing to the west as the Paleozoic rivers had done, were then flowing to the east.

That there has been vertical upward movement of importance since the close of Paleozoic time is evidenced by the development of well-marked physiographic features, such as the Cretaceous and Tertiary peneplains and the various river terraces found along the streams of the county.

¹ Piedmont Folio, U. S. Geol. Survey, 1896.

THE MINERAL RESOURCES OF ALLEGANY COUNTY

BY

WM. B. CLARK, C. C. O'HARRA, R. B. ROWE AND H. RIES

The economic resources of Allegany county are confined almost wholly to its western portion. The chief product is coal, but the output of fire-clay and cement-rock has been, and is now, of much importance. Other products, such as iron ore, building-stone, road-metal, brick-shales, alluvial clays, etc., have been or may be worked to advantage.

In the middle and eastern parts of the county some of the limestones are a source of good agriculture lime and of excellent road-metal, although at present used only for local purposes. Mineral springs also, which have had some notoriety in the past, might possibly be made valuable again under favorable conditions. The predominating rocks in these portions of the county are shales and sandstones which give little promise of future value as mineral producers, but this dearth of mineral wealth is in part compensated for by the fertility of the soil; and the output of farm and forest products may always be depended upon as a source of revenue.

In the preceding pages, under the heads of Stratigraphy and Structure, much has been said that needs to be studied in connection with this chapter. Certain formations are there shown to contain minerals and rocks which are known to be of economic importance, and the geological positions of the strata bearing them are carefully located, together with their areal distribution. Other formations, from the data given, seem to contain no mineral or rock of commercial value, and judging from work carried on in these formations

elsewhere it seems that the information, so far as the economic resources of the formations are concerned, is final. Some exceptions may occur and mention of such will be made in the following pages. The various products will be taken up separately and discussed with such detail as their importance may seem to demand.

COALS.¹

The coal region of Allegany county is confined to a narrow belt near its western boundary. The coal seams occur in the Pottsville, Allegheny, Conemaugh and Monongahela formations, the first three containing the so-called "small-vein coals" and the last the "big-vein coal," which for more than half a century has been the source of the finest steam coal of the country.

DESCRIPTION OF THE COAL BASIN.

The Coal Basin of Allegany county lies in a high, hilly, gently synclinal valley between the Dans-Little Allegheny Mountain belt on the east and Savage Mountain on the west, and extends across the county from the Maryland-Pennsylvania line south-southwestward to the Potomac river. Its length is approximately twenty miles and its average breadth is about five miles. The northern end of the district lies wholly in Allegany county, but southward the Allegheny-Garrett county line gradually encroaches upon the basin until at the Potomac river the county line lies less than a mile west of the central axis of the syncline.

The prominent transverse ridge on which Frostburg stands connects the highest slopes of Dans and Savage mountains, dividing the valley into two unequal parts, and thus determines two distinct and unequal areas of drainage. The smaller area lying to the north of Frostburg is drained by Jennings Run and Braddock Run, while the southern portion, which forms about three-fourths of the entire coal basin, is drained by Georges Creek.

¹ A much more detailed report on the coal deposits of the state will soon be published by the Maryland Geological Survey. This will contain full discussions of the areal distribution, methods of mining and colorimetric properties of the different coals.

Jennings Run takes its rise just north of Frostburg and flowing first in a general north-northeasterly direction, approximately along the synclinal axis, then in an easterly direction, passing through the deep gorge in Little Allegheny Mountain, enters Wills Creek about one and one-half miles south of the state line. Braddock Run rises east of Frostburg, near Eckhart, flows nearly eastward through the Dans-Little Allegheny gap and also joins Wills Creek, entering it at the west end of the "Narrows." The source of Georges Creek, the principal stream of the coal basin, is about two miles northwest of Frostburg on the eastern slope of Savage Mountain. Flowing in a general south-southeasterly direction, until it reaches the central axis of the basin south of Frostburg, it becomes deflected to the south-southwest and then follows quite closely the axis of the basin, receiving important tributaries from either side, until it enters the Potomac at Westernport.

The various formations of the Coal Measures are generally composed of easily eroded materials, and consequently have suffered deep cutting by the various streams, so that, although the lower beds are but slightly affected, the upper beds are now represented only by irregular or rounded areas left as remnants on the tops of the higher hills. In this way, in addition to the two outcrops of the several coal seams along the outer edges of the basin, two outcrops have been produced along the gorges cut by the various streams. As the streams descend from higher to lower levels these outcrops continually rise higher above the stream beds, thus necessitating the use of steep gravity planes in the southern part of the basin in order to transfer the coal from the mine openings on the hillsides to the railroads in the valley below.

HISTORY OF ITS DEVELOPMENT.

Coal was discovered by a Mr. Riser near the present site of Frostburg in 1804, and, although various openings were made from time to time and a small amount of coal taken out, more than a quarter of a century passed by before mining operations of any note were inaugurated. The first eastern shipment of coal was made in 1830 from the

old Neff mine, now the Eckhart mine of the Consolidation Coal Company. The coal was loaded on barges at Cumberland and floated down the Potomac river to Washington. Although profitable for a time, this mode of conveyance was too destructive of life and property to be long utilized and was soon abandoned. The first shipments of coal over the Baltimore and Ohio Railroad were made in 1842, and over the Chesapeake and Ohio Canal from Cumberland in 1850. Since then shipments have been continuous and the record of annual output is complete from 1842 to the present time.

NAMES USED FOR THE COAL BASIN.

The names by which the coal basin and the coal seams of Allegany county are known are often confusing to the general reader. Owing to the fact that Fort Cumberland early gained great notoriety as a frontier outpost, and the important and thriving city which now occupies its former site became the business center of the upper Potomac valley, the Coal Basin, although the coal lay several miles to the west of the city, came to be known as the "Cumberland Coal Region." Primarily the term referred to that part of the coal area lying around and to the north of Frostburg. Later, as mines were opened throughout the whole length of Georges Creek, the term "Georges Creek Coal Region" also came into use. In the meantime Frostburg, rapidly growing and favorably situated with reference to the entire coal field, gave its name to the region without, however, supplanting either of the other two. This name, although much used locally, has never gained a firm footing in the trade literature of Maryland coal. The coal trade seems to prefer the terms Cumberland and Georges Creek, and as a result of this preference the combined term Cumberland-Georges Creek District or Basin is now gaining precedence in scientific literature. In this way there need be no confusion with the coal districts of neighboring areas and the coal-trade interests of the Georges Creek valley may be fully protected.

According to the classification given by Mr. Joseph D. Weeks of the United States Geological Survey, the Cumberland-Georges Creek

District is one of four districts which make up the so-called Potomac Coal Basin.¹ The other three are the Wellersburg District of Pennsylvania, the Elk Garden District of West Virginia and the Upper Potomac District of West Virginia, the latter two districts including also that part of the coal area of Garrett county which lies along the Potomac river.

THE COAL VEINS.

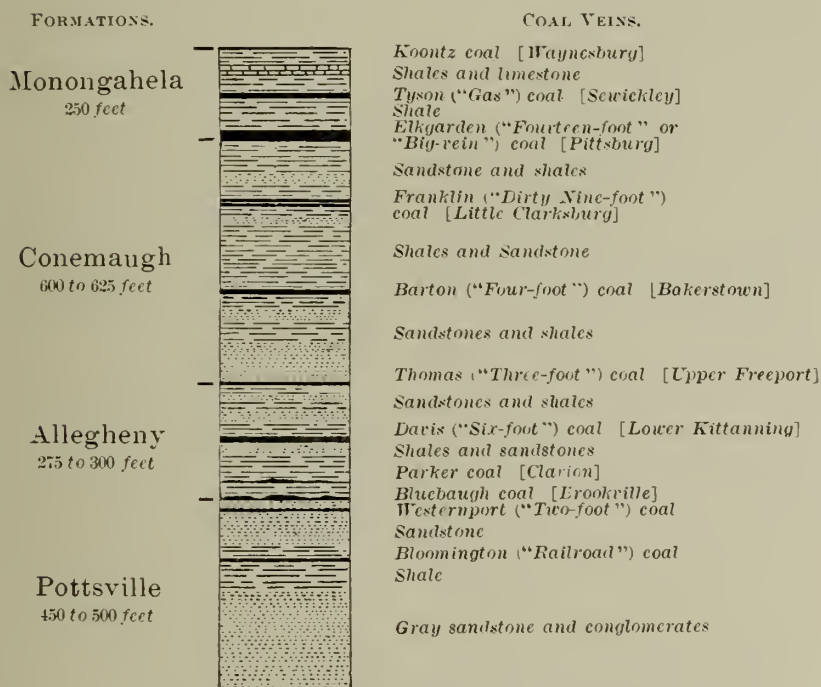


FIG. 5.—Section showing position of leading coal veins.

The coal veins of Allegheny county are found in the Monongahela, Conemaugh, Allegheny and Pottsville formations. Their character and position will be discussed in the following pages. The relations of the leading seams are shown in the above figure.

¹ Weeks, Jos. D. The Potomac and Roaring Creek Coal Fields in West Virginia. U. S. G. S. Ann. Rept., 1892-93, pt. II, pp. 567-590.

THE POTTSVILLE COALS.

The Pottsville veins are much less important commercially in Maryland than in Virginia, where they are represented by the important New River and Pocahontas coals. In Maryland only two veins have been exploited hitherto, and both of them, so far as known, are of small areal extent and thickness. The two veins are known respectively as the Bloomington (Railroad) coal and the Westernport (Two-foot) coal.

The Bloomington (Railroad) Coal.—The Bloomington coal, so named from the fact that it is well developed along the line of the Baltimore and Ohio Railroad to the west of Bloomington, covers a considerable area in southwestern Allegany county and adjacent portions of Garrett county. It has been commonly known under the name of the "Railroad Seam." Numerous attempts have been made to work this coal but with indifferent success, on account of the variable thickness and quality of the coal. The vein varies from one foot or less to nearly three feet in thickness, and this occurs within short distances. The coal is often very impure, bands of slate occurring in it. The following section near Piedmont represents the general character of the seam in the Potomac valley in the southwestern portion of the county, where it is best developed:—

	Feet.	Inches.
Sandstone.....	x	
Coal.....		3
Shale....		5
Coal.....	2	10
Shale.....		2
Coal.....		1
Black shale.....	1	

The Railroad seam occurs about 125 feet below the top of the Pottsville formation and about 170 feet above the Manch Chunk shales.

The Westernport (Two-foot) Coal.—The Westernport coal, so-called from its occurrence in the vicinity of Westernport, is only worked at the present time at a single locality on the east side of the lower Georges Creek valley. This vein, which has been referred to at

times as the "Two-foot vein," is limited so far as known to the southern portion of the Georges Creek basin. This coal is somewhat variable in thickness, like the Bloomington vein, but is usually about 2 feet 10 inches to 3 feet in thickness, and generally contains more or less slate interstratified with the coal. The lower bench carries more or less sulphur at times. The following section shows the thickness and character of the coal at the opening to the northeast of Westernport:

	Feet.	Inches.
Sandstone.....	x	
Coal.....	1	8½
Slate.....		1
Coal.....	1	3
Fire-Clay	x	

The Westernport coal is found at 20 feet below the top of the Pottsville formation and about 115 feet above the Bloomington coal.

Other Coals.—At each of the three fire-clay mines near the Allegheny line in the northern part of the coal basin a coal seam of some importance is found usually immediately above the fire-clay bed, the exact equivalency of which cannot be determined. Its thickness averages about two feet, but sometimes increases to four feet. It is about seventy-five feet below the top of the Pottsville formation.¹ This coal is mined at the Mount Savage and the Savage Mountain mines and has been used to some extent in burning the fire-brick.

THE ALLEGHENY COALS.

The Allegheny coals are among the most important of the small-vein coals in Maryland and are also worked extensively in the adjacent states of Pennsylvania and West Virginia, affording the important Somerset county coals of the former and several of the chief mines of the Davis Coal and Coke Company in the latter as well as many others further west.

The Allegheny coals, together with the Conemaugh coals above, undoubtedly have a great future in Maryland in the days to come when the Big Vein coal becomes more nearly exhausted. The areal

¹ See Gladden's Run Section. Bull. 65, U. S. G. S., p. 186.

extent of these small veins is so much greater than that of the more important Big Vein that the volume of small-vein coal in the state far exceeds that contained in the Big Vein, although its removal has proved to be much more difficult and expensive.

The Bluebaugh Coal.—The Bluebaugh coal, designated by this name locally, is confined, so far as known, to the northeastern rim of the Georges Creek basin, where it outcrops along the margin of the field from near Dans Rock northward. This coal lies at or near the base of the Allegheny formation and is very variable in thickness, changing rapidly within short distances. It generally contains bands of slate and some bone-coal. A mine opening at Warrior Run to the north of Dans Rock shows the following section:

	Feet.	Inches.
Sandstone and shale.....	x	
Coal.....	1	
Slate.....	1	4
Coal.....	3	4
Slate.....		1
Coal.....	1	1
Shale.....	x	

The vein is found but a few feet above the top of the Pottsville conglomerate. The Bluebaugh coal occupies a position very near that of the Brookville coal in Pennsylvania and it has been thought to be the approximate equivalent of that vein.

The Parker Coal.—The Parker coal so-called locally, is confined to approximately the same area as the Bluebaugh coal, and like that coal is variable in thickness. It varies from a few inches to very nearly 5 feet, but like most of the other small-vein coals, generally carries considerable slate, which greatly interferes with economy in mining. The Parker vein has been worked to some extent in the vicinity of Barrellville where it affords the following section:

	Feet.	Inches.
Slate and bone coal.....	x	
Coal.....		8
Shaly sandstone.....		6
Coal.....	2	
Sandy shale.....	x	

This vein thickens somewhat to the southward toward Warrior Run, where it has been estimated that a thickness of nearly 5 feet is

reached. The Parker coal is situated about 30 feet above the Bluebaugh coal. Its position indicates that it must be the approximate equivalent of the Clarion coal of Pennsylvania.

The Davis (Six-foot) Coal.—The Davis coal, so named by the geologists of the U. S. Geological Survey on account of its extensive development at and near Davis, West Virginia, is one of the most important of the small-vein coals. It is commonly known in Allegheny county as the Six-foot coal.

Starting at an elevation of about two hundred feet above the bed of the Potomac river near Westernport, the outcrops going northward gradually approach the level of Georges Creek until at a point a few rods north of Franklin they pass beneath its surface. The identity of the Six-foot coal is apparently better preserved throughout the basin than that of the Barton or the Thomas coals, and in addition to the openings at the mines now worked near Westernport this seam has been exploited in various places along the eastern slope of Savage Mountain and on the western slope of Dans and Little Allegheny mountains. Near Westernport, where the seam approaches six feet in thickness, the coal has been mined for a number of years, and although seldom put upon the market as a competitor of the Big Vein coal, it has nevertheless supplied a considerable part of the demand in Westernport and Piedmont, and is now finding a wider market.

Throughout the lower Georges Creek valley the Davis coal reaches a greater thickness, and is more important than any other coal except the Big Vein. This coal always contains partings of either shale or sandstone, while bone-coal is not infrequent. There is at times considerable sulphur in the lower bench. At some points in the lower Georges Creek valley the Davis vein is quite clean and, in general, seems to improve in quality southward. The following section is typical of the lower Georges Creek basin:

	Fect.	Inches.
Shale overlain by sandstone.....	x	
Bone coal.....		2
Top coal.....		10
Bone coal.....		6
Coal.....	1	11
Slate.....		$\frac{1}{2}$
Coal.....	2	2
Shale.....	x	

The Davis vein in Allegany county generally has a roof composed of shale, overlain by heavy sandstone. The Davis coal is situated about 125-150 feet above the base of the Allegheny formation. This vein is generally regarded as the approximate equivalent of the lower Kittanning coal of Pennsylvania.

The Thomas (Three-foot) Coal.—The Thomas coal, so-called by the geologists of the U. S. Geological Survey on account of its occurrence at Thomas, West Virginia, covers an extensive area in the Georges Creek basin, outcropping around the higher margins of the syncline, and also cut through by the Georges Creek itself in its lower course. This seam is commonly known in the region as the "Three-foot" vein (by some erroneously called "Four-foot" vein), although it seldom contains workable coal of that thickness. The vein varies in thickness from 2 feet 6 inches to 3 feet 2 inches. It thickens to the southward and at Thomas has nearly twice the thickness reached in the Georges Creek valley. This coal is quite clean and has been successfully opened to the north of Westernport. The following section of the "Three-foot" vein represents its thickness and character throughout the lower Georges Creek area:

	Feet.	Inches.
Shale	x	
Bony coal.....		3-5
Bone		7
Coal.....	2	10
Fire-clay	x	

The Thomas vein has a very characteristic shale roof and a fire-clay floor. It is situated directly at the top of the Allegheny formation, and about 155 feet above the Davis coal before described. The coal is generally regarded as the approximate equivalent of the upper Freeport coal of Pennsylvania.

Other Coals.—Several other coal veins are found in the Allegheny formation, but none of them have been successfully exploited, and under present conditions cannot be regarded as having much commercial value. The most important is the so-called "Split Six-foot Vein," which in the lower Georges Creek Valley has been found to contain locally nearly four feet of workable coal. Partings of slate

and bone seriously interfere with the value of the vein. It is situated about 25 to 35 feet below the Davis coal.

THE CONEMAUGH COALS.

The Conemaugh coals are of less importance than the Allegheny coals, although affording one vein that has already been successfully exploited in the Georges Creek basin and in adjacent areas. This coal, the Barton (Four-foot) coal, may be regarded as possessing much future commercial value.

The Barton (Four-foot) Coal.—The Barton coal, so-called from its occurrence in the vicinity of Barton, covers a considerable area in the Georges Creek region. This vein is locally called the “Four-foot” vein, although, by an unfortunate interchange of names, it has at times been erroneously referred to by some as the “Three-foot” vein. The Barton coal varies in thickness from 2 feet 0 inches to 2 feet 11 inches, its thickness, therefore, being considerably less than its name indicates. Its principal features appear fairly persistent throughout the southern part of the basin, where it has been most examined. Like all of the coal-beds situated below the Big Vein, its position in the north-central part of the district is so far beneath the surface that it may be considered of little immediate value, even though the purity and thickness should prove wholly satisfactory. Southward, however, it gradually approaches the surface and emerges above the bed of Georges Creek fifty yards north of the long railroad bridge one-half mile north of the village of Moscow. At this point, where a small amount of coal has been taken out by private individuals for home use, the thickness is 2 feet 8 inches. One-half mile east of Barton on the Potomac tramroad, where this seam has been opened, the workable coal is 2 feet 6 inches thick.

Southward from its point of emergence above Georges Creek the coal outcrops along the hillsides, and, continually rising higher above the creek level, can be easily traced by means of the many excavations made in it.

The Barton coal is generally quite clean at the points where it has been opened in the central and lower portions of the Georges

Creek valley. The following section of the Barton coal is characteristic of the lower Georges Creek area:

	Feet.	Inches.
Black jack, bone and slate.....	x	
Coal	2	4
Bone coal.....	x	

The Barton coal is situated about 250 feet above the Thomas coal and is commonly about 425 feet below the Big Vein. It is probably the equivalent of the Bakerstown coal of adjacent states, although this equivalency cannot be very satisfactorily shown.

The Franklin (Dirty Nine-foot) Coal.—The Franklin coal, so-called from Franklin in the lower Georges Creek valley, where a good section of the vein is exposed in the old Franklin Plane, is locally called the “Dirty Nine-foot” vein. This coal had never been worked to any great extent, and has little commercial value. It is, as its popular name signifies, very dirty, and at many points entirely unworkable. With its contained slates it varies in thickness from 5 feet 10 inches to 10 feet 4 inches. It is somewhat thicker at Franklin than in the portions of the Georges Creek valley to the north and south of it. The following section near the Franklin Plane shows the general character of the coal:

	Feet.	Inches.
Sandstone.....	x	
Shale	1	6
Shale with thin coal vein.....	8	
Coal	2	3
Slate and coal.....	x	

The Franklin coal is the approximate equivalent of the Little Clarksburg Vein of West Virginia.

Other Coals.—There are a number of other small veins found in the Conemaugh formation, but they have little commercial value, either on account of the extreme thinness of the coal vein itself or the numerous slates which are interstratified with the coal. It is hardly probable that they can ever be worked with profit.

THE MONONGAHELA COALS.

The Monongahela coals, although of much less areal extent than those which have hitherto been described, are by far the most important in Allegany county, since they contain the wonderful Fourteen-foot or Big Vein. The smaller Monongahela coals are much less



FIG. 1.—PUMPING STATION, CONSOLIDATION COAL CO.



FIG. 2.—MINING PLANT AT OCEAN, NO. 1.

COAL MINING IN ALLEGANY COUNTY.

important than several of the small veins occurring in the Allegheny and Conemaugh formations and their operation hitherto has not been attended with any great success. The three more important veins found in the Monongahela formation are the Elkgarden (Fourteen-foot or Big Vein) coal, the Tyson (Gas) coal, and the Koontz (Waynesburg) coal.

The Elkgarden (Fourteen-foot or Big Vein) Coal.—The Elkgarden coal, so named by the geologists of the U. S. Geological Survey from Elkgarden, West Virginia, where this seam is well represented, is generally referred to in Maryland as the Fourteen-foot or Big Vein coal and is much more extensively developed in the Georges Creek Basin than in West Virginia. The Big Vein originally covered an extensive area in the Georges Creek Basin, but in the more than a half of a century that this coal has been actively mined large tracts have become entirely exhausted. It occurs at present in largest volume in the central and northern portions of the field, in the vicinity of Frostburg. This Big Vein varies in thickness from 5 or 7 feet up to more than 20 feet, the latter thickness having, moreover, been exceeded at one or two isolated points where pockets of unusual thickness have been reached. Its usual thickness is from 10 to 12 feet and, in general, it has been found to thicken southward. The coal is very clean and of the highest quality, affording a low percentage of both ash and sulphur. It is in most respects the finest steam-coal known, and is extensively used where the highest grade coals are demanded. The following section made just below Lonaconing, is representative of the Big Vein coal in that part of the Georges Creek Basin:

	Feet.	Inches.
Slate	x	
Wild coal	1	
Fire-clay	1	
Roof coal	2	
Bony coal		8
Breast coal	8	
Slate		1
Coal	$\frac{4}{16}$ in. }	
Slate	1	
Coal	1 ft. }	
Slate	$\frac{4}{16}$ }	
Coal	10 }	
	Bottom coal..	2
		$3\frac{1}{2}$

The Elkgarden coal occurs at the base of the Monongahela formation, and is probably the equivalent of the Pittsburg Vein of Pennsylvania and West Virginia, although on account of the structural conditions under which it is found it differs materially from the latter in its physical and chemical properties.

Thin persistent bands of slate or dry partings subdivide the Big Vein coal into three definite members, each of which possesses special characteristics. These beds are known as Roof coal, Breast coal and Bottom coal.

The Roof coal includes several more or less important layers of coal of varying purity and thickness separated by thin beds of shale. Except in the northern part of the basin these roof coals are not removed in mining, since they are of particular importance as a support for the overlying strata.

The Breast coal is the thickest and the most valuable member of the Big Vein coal. North of Frostburg it seems to retain its purity through a thickness of scarcely more than two feet, while south of Lonaconing it is sometimes more than seven feet thick and without impurities. Near the top there is a two to eight-inch layer of bony coal, but this is rarely sufficiently impure to necessitate its rejection. Near the bottom there is a four to six-inch band of soft "mining ply" which is jet black, has a brilliant luster, and shows a strong tendency to break into small cubical blocks.

The Bottom coal is from two and one-half to three feet thick and generally contains two thin slate bands. Other impurities are sometimes present but they are seldom of a very serious nature. On account of the slate bands the Bottom coal for many years was not mined, but under an improved system of mining these thin slates are now easily removed and the coal readily taken up.

On the whole the slates thin perceptibly from north to south and the coal members thicken greatly in that direction, the total thickness of workable coal in the vicinity of Franklin being in some places considerably more than fourteen feet.

The structure of the coal is chiefly columnar though sometimes shaly. The columnar portions generally have a deep, shining jet

appearance, the shaly portions a dull black. The cohesion is weak, a slight blow causing fracture.

The coal is semi-bituminous and contains on an average about nineteen per cent. volatile carbon, seventy-four per cent. fixed carbon, less than six per cent. ash and less than one per cent. sulphur.

The Big-Vein coal is mined by all of the leading coal companies, among them The Consolidation Coal Co., The Georges Creek Coal and Iron Co., The Black, Sheridan, Wilson Co., The American Coal Co., the Maryland Coal Co., the New Central Coal Co. and the Davis Coal and Coke Co.

The Tyson (Gas) Coal.—The Tyson coal, often referred to locally as the "Gas" coal, is found widely in the Georges Creek Basin. Attempts have been made from time to time to work this coal, but the results have not been very satisfactory. The vein varies from 4 feet 7 inches to 7 feet 3 inches in thickness. The coal is moderately clean, but in other respects is inferior to the Big Vein coal in quality. Like the Big Vein, the Tyson coal is separated by thin slates into three members, the top coal being generally more than twelve inches thick, the middle coal from three to four feet and the bottom from one to two and one-half feet. Near Franklin the thickness of good workable coal is seven feet, but in the vicinity of Lonaconing it is scarcely four feet. The following section represents the general character of the Tyson seam in the Georges Creek region.

	Feet.	Inches.
Shale	x	
Coal with thin slates.....	6	2
Shale and fire-clay	x	

The Tyson seam occurs at about 120 feet above the top of the Big Vein. It is probably the equivalent of the Sewickley coal of Pennsylvania.

The Koontz Coal.—The Koontz coal, so-called from its occurrence in the vicinity of Koontz near the head of Koontz Run, has been prospected with some success, but the coal has not been worked to any great extent up to the present time. The areal extent of the Koontz is very small, occupying the higher lands of the Georges Creek Basin.

The vein varies from 5 feet 9 inches to 7 feet 9 inches. The coal is moderately clean, but like the Tyson vein, is inferior to the Big Vein. Near the Koontz mine, where this seam has been perhaps the most extensively worked, great trouble was occasioned by numerous fissures, on account of which the mining of it was finally abandoned. The main drift entered this seam a distance of 1164 feet, during the course of which twenty-one fissures were found, one of the fissures being more than twelve feet in thickness. The following section represents the general character of the seam in its typical locality.

	Feet.	Inches.
Coal.....	2	3
Bone.....		4
Coal.....		6
Bone.....		7
Coal.....	1	3
Slate.....		10
Coal.....		5
Shale.....	x	

The Koontz seam caps the Monongahela formation and is found at an elevation of about 110-130 feet above the Tyson vein and about 230-250 feet above the top of the Big Vein. The Koontz coal is the probable equivalent of the Waynesburg coal of Pennsylvania.

Other Coals.—Several other small veins are found in the Monongahela formation, one on the west side of the valley being found at 29 feet above the Big Vein and containing about $4\frac{1}{2}$ feet of coal. This coal has been hardly more than prospected for as yet, and it is doubtful if it has any commercial importance. It is the approximate equivalent of the Redstone coal of Pennsylvania.

CLAYS.

The clay resources of Allegany county include fire-clays, residual clays, sedimentary clays and shales. They represent an inexhaustible supply of material capable of being used in the manufacture of different grades of clay products. While the value of the fire-clays has been known since an early date, the other clay materials remain practically untouched.

FIRE-CLAYS.

All of the beds of fire-clay thus far discovered in the county lie in the Pottsville formation, their position being under the Homewood sandstone. Extending across the western border of the county in a N.E.-S.W. direction is the great synclinal trough of the Georges Creek coal basin, and it is near the rim of this that the fire-clay beds outcrop and are mined. These fire-clays were first discovered in 1837 at Mt. Savage, and employed for lining two blast-furnaces then in use at that locality by the Maryland and New York Coal and Iron Company.

In 1841 a fire-brick plant was opened at Mt. Savage, which has been in operation ever since, so that now bricks made from Mt. Savage fire-clay bear a national reputation.

The fire-clay beds have been opened up at three different mines, viz., on Savage Mountain, $2\frac{1}{2}$ miles northwest of Frostburg, on the same mountain $2\frac{1}{2}$ miles west of Mt. Savage, and on Little Allegheny Mountain 2 miles west of Ellerslie. At these three points the clay occurs in a bed from 8-14 feet thick, and is commonly overlain by a thin bed of coal. Two types of fire-clay are found, viz., the soft or plastic clay and the hard or flint clay. Both possess the important quality of refractoriness, and they may even agree closely in composition, but they differ widely in plasticity. The soft clay is highly plastic, while the hard clay, even after being ground, is devoid of this character. They therefore serve two different purposes: the one acts as a bond, the other decreases the shrinkage; and they are consequently mixed in suitable proportions, care being taken to use as much of the hard as possible.

No fixed method of occurrence of the two clays exists, for in one mine the soft may be on top, while in another the hard clay forms the upper members.

In mining the custom is to run in a drift from the face of the slope until the bed of clay is met and then follow it with gangways in different directions. In these gangways tracks are laid for the cars. Owing to the looseness of the roof, much timbering has to be employed.

The prevailing method of manufacture is to charge the hard and soft clay into a wet pan, adding the necessary amount of water. This results in grinding up the clays and tempering or mixing them at the same time. One exception to this is the Ellerslie works, where the clay receives a preliminary grinding in a dry pan.

The tempering in the wet pan takes but a few minutes, and one pan can in 5 or 6 hours temper enough clay for eight or ten thousand brick.

The tempered mixture is carried to the molding tables and pressed by hand in wooden molds, after which the soft bricks are spread out on brick-drying floors heated by flues underneath. After remaining several hours on this floor, the bricks are put into a repressing machine, which not only makes the bricks denser but gives them a more regular shape. They are then burned in kilns, of which several different types of either up or down-draft pattern are used in the Allegany county works. A noteworthy feature of the Union Mining Company's plant at Mt. Savage is the use of two continuous kilns, which are heated by means of producer gas, generated in producers run on a track alongside the kiln. The use of these producers causes economy of fuel and, furthermore, with the continuous kiln system the waste heat is used for heating up the chambers not yet burned. The burning occupies 5-6 days, and the cooling several days more.

The Mt. Savage Enameled Brick Company is engaged in the manufacture of enameled brick, the raw materials used being a mixture of hard and soft fire-clay. The bricks made are mostly white, although other colors are used. Recently the company has undertaken the manufacture of fancy shapes. Among the buildings in which large quantities of these bricks are used are the Buffalo Post Office; Back Bay Station, Boston; Union Depot, Boston; etc.

SHALES.

The Carboniferous and Devonian rocks of Allegany county contain a vast series of shales, as can be seen from an inspection of the geological map and sections accompanying this report.

Shale is simply clay which has been consolidated by pressure, and,

consequently, when ground and mixed with water, it usually develops the same degree and kind of plasticity that soft clay shows. It is often found especially adapted to the manufacture of vitrified goods, for its extreme fineness of grain and homogeneity permit it to soften evenly and thoroughly by the action of heat. Allegany county possesses a large supply of this material, distributed not only in the eastern but also in the western half of the county. The former are of Devonian and the latter of Carboniferous age.

The Carboniferous shales are at times closely associated with the coal-seams, while at others they are several feet distant from them. It is a common custom among coal miners to speak of shale underlying coal as fire-clay; and while this often holds true in some regions, it must not be taken as a universal fact.

Along the Georges Creek valley there are numerous outcropping beds of shale, some of them favorably located for working. Among them may be mentioned outcrops on the hillside opposite Gannon's plane between Franklin and Piedmont, West Virginia; on the east side of Georges Creek at Barton; also in Gannon's new tunnel opposite Franklin School House, and again beyond the pumping shaft.

On the western side of Savage Mountain the Mauch Chunk shale is well exposed, and in places affords very plastic outcrops. Its mixture with the neighboring fire-clays might yield interesting results. These shales are usually fine-grained, moderately hard and would probably grind up to plastic mixtures without much trouble.

The Devonian shales form a series of beds of great thickness in Allegany county, and are well exposed in places, especially east of Cumberland.

While they also occur at the southern end of the county, still they are usually hidden by a heavy covering of talus. At Keyser, West Virginia, the Romney shales are exposed along the railroad tracks on the north side of the creek.

Passing east from Cumberland, one traverses a series of outcrops of Jennings, Portage, Genesee, Hamilton and Marcellus shales. The upper portions could be well utilized in the manufacture of clay products, and even the lower parts may find similar use.

At South Cumberland, at a point near the crossing of Evitts Creek by the Baltimore and Ohio Railroad, the upper shales of the Jennings (Portage) are yielding excellent results in the manufacture of a brick of high density and fine red color. The shales employed here, although in part appearing extremely hard, slake down to a plastic clay. The South Cumberland Brick Works have five kilns in operation here.

At Potomac Station the Clinton and Salina shales are well exposed, the former on the hill above the cement works and the latter on the slope to the south and adjoining the quarries. The Salina, owing to its siliceous character, is not worth considering, but the Clinton, if not too calcareous, might be useful.

The Juniata (Medina) shales are exposed along the northern side of the "Narrows" just west of Cumberland, but they are so interbedded with sandstone as to render their working impracticable.

Aside from their use in the manufacture of clay products, such as brick, terra cotta, etc., there is still another direction in which the shales might be employed, and that is for the manufacture of Portland cement.

The shales at Keyser, West Virginia, have Helderberg limestone near by, the Carboniferous shales in Georges Creek valley are not far from Carboniferous limestone, and the same conditions apply to the shales around Cumberland.

SEDIMENTARY CLAYS.

Sedimentary clays are mostly found in the broader valleys. They underlie the flats at Cumberland, Potomac, etc. They are commonly siliceous, and while well adapted to the manufacture of common brick or even flower pots, their use ends there.

RESIDUAL CLAYS.

Residual clays, derived from the Helderberg limestone, occur in the northern central portion of the county on the Maryland side of the Potomac river. At Bier and at Keyser it is used exclusively for the manufacture of brick. At Cumberland both brick and pottery are made.

In the north-central part of the county the residual clays resulting from the decomposition of the Helderberg and Silurian limestones are available in abundance but have been little used.

In addition to the soft clays the argillaceous shales of the Romney and Jennings formations would no doubt afford an inexhaustible supply of good clay if for any reason it should seem desirable to work them.

LIME AND CEMENT PRODUCTS.

Lime and hydraulic cement are extensive products of Allegany county. That part of the Salina formation commonly known as the "Waterlime Group" which is so much utilized in the northern Appalachian region for the manufacture of hydraulic cement, is worked at Cumberland and at Potomac. Operations have been important and almost continuous at Cumberland since 1836, at which time the cement from the Salina beds was first used in Maryland. Work at Potomac was begun in 1891, since which time the cement rock there has been mined extensively.

The cement mine at Cumberland, which is under the management of the Cumberland Hydraulic Cement and Manufacturing Company, is situated on the south side of Wills Creek, where the cement beds are folded and well exposed, allowing convenient access to the rock along the strike. At Potomac, where the rock is mined by the Cumberland and Potomac Cement Company, the strata stand upright and are even better exposed than at Cumberland.

The cement rock proper occurs, as earlier shown, in beds of varying thickness separated by impure calcareous shales. Only four of these beds have sufficient thickness and purity to be economically worked. These all lie within the "cement series" of the Salina formation, and vary in thickness from six to seventeen feet.

The first or lowest cement rock is of but little value when worked alone, but when mixed with material from the other beds can be used to advantage. The second is worked most extensively and yields the finest quality of cement. The third is not so good as the second, but can be profitably used by mixing with it. The fourth is also not so good as the second, but is better than either of the others.

In general, the rock varies from a dark bluish gray to a dull black; is quite shaly, frequently showing thin limestones, breaks readily and usually contains few or no fossils. The chemical composition of the rock at Cumberland has been found to be as follows:

Carbonate of lime.....	41.80
Carbonate of magnesia	8.60
Silica	24.74
Alumina	16.74
Oxide of iron	6.30

Aside from the exposures at Cumberland and Potomac, the cement beds are not well shown in Allegany county, although with a little effort they might be reached in other localities. In the north-central part of the county the beds are doubtless developed as fully as further west, but they are not well exposed and lack of transportation facilities necessarily prevents their development.

The Helderberg formation supplies nearly all of the lime made in the county. The limestone is extensively burned at several places in the immediate vicinity of Cumberland, and in addition to supplying the local demand for building purposes, considerable shipments are made. A kiln at a small quarry north of Cresap near the Georges Creek and Cumberland Railroad supplies a part of the Frostburg demand. In a few places west and southwest of Flintstone small kilns have been constructed, but the burning of the lime has been carried on at very irregular intervals and then only for local use, chiefly for fertilizing purposes.

In addition to the Helderberg limestone, the Coal Measures limestones have been burned to some extent for agricultural and building purposes and have also been used for fluxing iron ores. For the latter purpose one of the higher limestones of the Dunkard formation, quarried about two miles southeast of Frostburg, was used extensively during the time of the development of the Carboniferous iron ores in the Cumberland-Georges Creek region. The heavy limestone of the Conemaugh exposed on the Potomac gravity-plane was quarried for a time, but that has been abandoned. Other limestones of the Coal Measures have been burned occasionally in a small way, but at present they are rarely used.

The Greenbrier limestone would no doubt make lime of excellent quality, but it has apparently never been tested in Allegany county. The outcrops, however, are usually not good, and even on Stony Run, where the formation is best exposed, many of the purest beds are not accessible.

Likewise the Niagara and the Romney limestones are rarely well exposed, and the far greater ease of access to the excellent Helderberg limestone will perhaps always prevent their use.

BUILDING STONE.

Building stone in almost unlimited quantity is found in the Tuscarora, Oriskany, Pottsville and Conemaugh formations. The heavy Carboniferous sandstones and conglomerates of the Pottsville and the Conemaugh have been used considerably for heavy bridge material on the various railroads in the county and for general foundation work in the coal basin. For all of these purposes this material has proved to be satisfactory, but no building of importance has been constructed entirely of it, the highly iron-stained condition of this stone precluding its use for such purposes.

The Oriskany formation has in the past furnished the material used in the construction of many good buildings in Cumberland, the most prominent being the Protestant Episcopal Church, the stone for which was quarried from a hillside near the center of the city. When fresh, this stone varies in color from a pure white to a bluish-gray, but with slight exposure it changes to a light brown or buff. It is made up of medium fine to coarse slightly angular fragments held together usually by a calcareous cement. Owing to its rapid discoloration and to the marked disintegration around the numerous fossils which this stone contains, its use in the construction of important buildings is much less extensive than in former years. Its convenience, however, to Cumberland and the ease with which it is quarried give to this stone a permanent local value.

The Tuscarora quartzite, until comparatively recently, has been little used. It is less heavily bedded than the Oriskany and much harder to dress, but owing to its almost snowy whiteness and its com-

parative freedom from substances likely to mar its beauty, the Tuscarora deserves, and is now commanding, much more attention than formerly, especially in the vicinity of Cumberland, where it is found. The stone thus far quarried from the Tuscarora has been used largely for curbs, steps and cemetery work, as well as for trimmings in some of the best buildings in Cumberland. It is nowhere systematically quarried for building purposes, but it can be advantageously reached by railroad in many places along Wills Mountain.

ROAD MATERIALS.

Good road material is abundant in Allegany county. Limestone in available quantity is found at several geological horizons and only in the eastern part of the county is it wholly absent. The cherty beds at the bottom of the Oriskany formation disintegrate deeply into a talus of small angular fragments which furnish an easily prepared material of excellent quality. The massive limestone beds in the Helderberg formation below the cherty layers, although nowhere systematically quarried for road use, have nevertheless furnished at various times large quantities of highly satisfactory stone for use on the National Road.

Some of the Niagara limestones might be of local value should a demand for them arise, but these are perhaps too much concealed and too near the better exposed Helderberg to be used very extensively. Likewise the limestone beds near the bottom of the Romney formation are available in a few places, but their impurities and their general concealment will no doubt always prevent their extensive use.

Greenbrier limestone makes excellent road-metal, and although not worked in Allegany county, large quantities have been brought into the county and used as ballast on the Baltimore and Ohio Railroad. In Allegany county the Greenbrier can be successfully quarried in only three localities, viz., on Jennings Run, Braddock Run and on Stony Run. Even at these places the outcrops are much concealed.

The Coal Measures limestones are numerous but rarely well exposed. Along the Cumberland and Pennsylvania Railroad about

two hundred and fifty yards north of the Frostburg tunnel limestone from the lower part of the Dunkard formation has been obtained for the streets of Frostburg. Formerly a considerable amount of material was obtained for the same purpose in the upper part of the Dunkard formation near the Consolidation Coal Company's pumping shaft two miles south of Frostburg. Monongahela limestone apparently of excellent quality could be procured at slight expense along the Carlos Branch Railroad south of Frostburg. This is a massive dark blue limestone which gives a very perceptible metallic ring when struck with a hammer. For local uses other limestones in the coal basin could be made available if desired.

The enormous talus slopes of Tuscarora quartzite in the Narrows near Cumberland yield an abundance of hard white rock which for several years has been crushed for use as railroad ballast.

IRON ORE.

No iron ore is now mined within the county and the future gives little promise in this direction. Allegany county in the past, however, has been closely connected with the iron trade and of this especial mention needs to be made. As early as 1837 the iron industry was fairly inaugurated. During this year the Georges Creek Coal and Iron Company began the erection of a furnace at Lonaconing fifty feet high and fourteen and one-half feet wide at the boshes. In June, 1839, it was making about seventy tons of good foundry iron per week, using coke as fuel. In 1837 two large blast furnaces were begun at Mount Savage by the New York Coal and Iron Company and were completed during the following year. In 1845 the same company built another furnace, but it was not lined and was never used. The Mount Savage rolling-mill was built in 1843 especially to roll iron rails and during the summer of 1844 it rolled the first heavy rails rolled in America. In honor of that event the Franklin Institute of Philadelphia awarded a medal to the proprietors in October, 1844. The rails were of inverted U form and weighed, forty-two pounds to the yard, and the first few hundred tons were laid on the railroad between Mount Savage and Cumberland. J. M.

Swank says that Allegany county is entitled to two of the highest honors in connection with the American iron trade: "It built the first successful coke furnace and rolled the first heavy iron rails."¹ In 1846 a furnace was built at Cumberland which at first used charcoal and afterwards used coke. This furnace was not long in operation. The blast furnace at Mount Savage continued in operation longer, but the gradually changing conditions of the iron trade caused its final abandonment in 1868. The foundry, however, was not given up and continues in operation at the present time.

So far as known, most of the iron ore used in Allegany county came from the Coal Measures strata. Much of it was found near the middle of the Conemaugh formation, but not a little was obtained from the lower part of the Monongahela. According to Professor Tyson, the fossil ore of the Clinton formation was also used extensively for a time both at Mount Savage and at Lonaconing.

Iron ore occurs in almost every geological formation in the county and even where not well exposed may frequently reveal itself as loose pieces lying upon the surface of the ground. Much of the ore is, however, of no practical value, but when the condition of the iron trade is not at its best, attempt at the development even of the richest of deposits is almost sure to prove unsuccessful. Aside from the Carboniferous and Clinton ores which have already been worked, the only horizon which, so far as known, might give even the slightest hopes of success is near the bottom of the Romney. Iron ore has been prospected for in many localities, but in no place has it been found in sufficient quantity to be available. It is liable to occur in pockets of no great extent, and generally of slight thickness.

The iron ores of the Clinton formation are exposed to good advantage in several places in the county where they can be easily reached at any time if desired. The lower ore is one hundred sixty feet above the Clinton-Tuscarora contact, as observed south of Cumberland on the Baltimore and Ohio Railroad one mile south of Bradys. Here the ore is in two bands, the lower one four and one-half

¹Swank, James M. History of the Manufacture of Iron in all Ages. Philadelphia, 1884.

feet thick and the upper one more than eight feet thick. Between the two are six and one-half feet of shales. Apparently the ore bed exposed on both sides of Wills creek west of the cement mill in Cumberland is the same as that near Bradys, but the twin character is not so prominently developed at Cumberland. The upper Clinton ore band, very similar to those just mentioned, is found immediately above the ten-foot sandstone, near the top of the formation. This ore was formerly mined, and for a time furnished much of the ore used in the county.

The Clinton ore is a highly fossiliferous hematite varying in color in weathered outcrops from a dull brown to a deep red. Concerning the changes brought about in the limestone beds, in connection with which the ore was formed, Professor J. P. Lesley says: "The protoxide of iron is mostly in combination with carbonate of lime as a triple compound, carbonate of protoxide of iron and lime. The iron-ore beds when followed far enough beneath drainage level, show by chemical analysis that this is their constitution. Above drainage their carbonate of lime has been dissolved and carried off; their carbonate of iron has received a double charge of oxygen, and remains behind as red hematite iron ore."

The Coal Measures ore bands are carbonates and limonites, the relative purity and thickness of which vary greatly. Little is known regarding the character and extent of these deposits, as they have been but little exploited hitherto. Their position and approximate thickness are indicated in the various sections which have been given in the chapters on the Stratigraphy and Structure.

MINERAL AND ORDINARY SPRINGS.

The only springs in Allegany county that have been especially noted for their mineral properties are the sulphur springs situated in the north-central part of the county. One of these, known as the Flintstone Sulphur Spring, is near the center of the village of Flintstone, and was for many years a source of considerable revenue. About four miles southeast of Flintstone there is a group of springs formerly considered of much importance. These are situated be-

tween Polish Mountain and Green Ridge on property once owned by William Carroll, and are known as the Carroll White Sulphur Springs. The sulphur in these springs, as well as in the Flintstone spring, is very perceptible to the taste, and a deposit of sulphate quickly settles upon the rocks over which the water flows.

Little need be said concerning the ordinary springs except to speak of their abundance and general distribution. Along the Tuscarora-Clinton, the Oriskany-Romney, and the Mauch Chunk-Pottsville contact lines excellent springs are particularly numerous. Many good springs occur elsewhere, but throughout the greater part of the county they are not so strong nor so regularly distributed as along the lines indicated. A few important exceptions occur. These are often closely related to disturbed strata, an excellent example of which may be seen to good advantage at the "Big Spring" one mile southwest of Rush. This is perhaps the strongest spring in the county and its waters flow from a local anticline in the Helderberg limestone.

MISCELLANEOUS MATERIALS.

In addition to the economic resources already discussed, the possible development of some other industries deserves mention. Glass-sand is now obtained in the Narrows near Cumberland as a by-product in the crushing of Tuscarora quartzite for railroad ballast. The quality of the sand thus obtained is excellent, but for extensive use the rock is too difficult to pulverize. The Oriskany sandstone is the great glass-sand producer of the Northern Appalachians and there are such extensive outcrops of this rock in Allegany county that the question of its utility has merited some study. Owing to the great abundance of good glass-sand elsewhere, and the somewhat limited demand for the article as compared with the supply, it is necessary for the rock to be of the highest quality and most favorably located to become of economic value. So far as known, no special prospecting has been done hitherto to learn of the possible value of the Oriskany sandstone as a glass-sand producer in Allegany county, but the surface indications are unfavorable. Generally this sandstone is highly iron-stained, but where not so, especially along Warrior Moun-

tain, its exposed surfaces show a hardness almost equal to that of the Tuscarora.

The deep red argillaceous shales at the bottom of the Mauch Chunk possess qualities which seem to indicate their adaptability as a cheap paint, and it has been used, although not extensively, for that purpose. Recently attention has been called to the dark reddish-brown loam which is sometimes found at the outcropping edge of the Big Vein coal, where seepage of its highly charged iron waters has caused the deposition of much ferruginous coloring matter. Recently several car-loads of this loam were shipped from near the Potomac mine to the paint works at Keyser, West Virginia, for testing as to its value as a paint producer.

Near the bottom of the Pottsville formation a four-foot bed of black siliceous oolitic rock, strikingly like some of the Tennessee phosphate rock, has been observed. Upon analysis it was found that the rock contains considerable phosphate, but not in sufficient quantities to make it of economic value. It is not impossible that further investigation in other areas may reveal deposits richer in phosphate. The only place in Allegany county where this phosphatic rock has been observed is about forty feet above the bed of the Potomac river on the wagon road one and one-fourth miles southeast of Westernport. The rock here is much weathered and possesses little of the characteristics of the fresh material. Loose slabs of the rock, in a much less weathered condition, were found in considerable abundance on the West Virginia side of the Potomac.

LIST OF OPERATORS IN MINERAL PRODUCTS IN ALLEGANY COUNTY.

COAL.	
NAME.	ADDRESS.
Consolidation Coal Company.....	Baltimore.
Black, Sheridan, Wilson Company.....	"
Georges Creek Coal and Iron Company	"
Big Vein Coal Company	"
Lonaconing Coal Company	"
Barton Mining Company	Barton.
Sinclair Mining Company.....	Cumberland.
Malcolm Sinclair	"
Borden Mining Company	Frostburg.
H. & A. Hitchins.....	"
American Coal Company	Lonaconing.
Maryland Coal Company	"
New Central Coal Company	"
A. J. Merrill	Westernport.
J. O. J. Greene	"
Atlantic and Georges Creek Consolidation Coal Co...	Piedmont, W. Va.
Piedmont-Cumberland Coal Company	" "
Piedmont Mining Company.....	" "
Davis Coal and Coke Company	Philadelphia, Pa.

CLAYS AND SHALES.

P. A. Bier.....	Bier.
Peter Alkise	Cumberland.
H. Brant.....	"
Eichner Bros.....	"
Queen City Brick and Tile Company.....	"
James Gardner & Sons	"
Savage Mountain Fire-Brick Works	Frostburg.
Knight and Purgit.....	Keyser, W. Va.
Union Mining Company.....	Monnt Savage.
Monnt Savage Enameled-Brick Company.....	" "
George E. Rawlings	Pinto.

LIME AND CEMENT.

Chas. F. Treaseher.....	Cresaptown.
Robert Oss	"
Joseph Dressman.....	Cumberland.
Cumberland Hydranlic-Cement Company	"
Wm. T. Mullan	"
Cumberland Valley Cement Company	"
S. K. Berry	Flintstone.
Cumberland and Potomac Cement Company	Pinto.
C. Long & Bros.	"
G. M. Rawlings	"

BUILDING-STONES.

Beall Bros. (sandstone).....	Cumberland.
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FLINT AND CHERT.

John Dressman	Cumberland.
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THE SOILS OF ALLEGANY COUNTY

BY

CLARENCE W. DORSEY

INTRODUCTION.

The soils of Allegany county are so closely related to the geological formations from which they are derived that a knowledge of the rock formations throws much light upon the soils which are found there. From an agricultural standpoint, the soil may be regarded as the uppermost layer of the earth's crust which supports vegetation. It is often spoken of as the *débris* of rocks more or less mixed with decayed organic matter. In its composition, soil consists of fragments of rocks and the products of rock decomposition, together with the remains of animal and vegetable life, the mass being permeated with more or less water containing various substances in solution.

THE FORMATION OF SOIL.

The mechanical forces which are active in the formation of soils are, to a great extent, familiar to everyone. The result of their action is to continually break rock-masses into smaller fragments until they are reduced to such a size that the roots of plants can obtain support when the processes of soil formation are greatly hastened. In the winter, water which has penetrated the joints and crevices of rocks becomes frozen, thereby causing the rocks to be pried asunder. The roots of trees effect the same result by wedging rocks apart. The reduction of rocks to fine particles is brought about by the beating of the rains. The grinding of particles of dust carried by the winds, the friction of the wind itself and the erosive power of moving water and ice. Rocks expand on heating during the day and contract at night, causing the particles to become loosened and in time

to fall apart. This action is more pronounced in mountainous countries than in regions of less elevation.

The chemical forces which act upon rocks are not so easily recognized by the inexperienced observer, but they are nevertheless powerful in promoting rock degeneration and their action may be noticed hundreds of feet below the earth's surface. Rains falling upon the earth dissolve substances contained in rocks, leaving the relatively insoluble particles of matter. This is illustrated in a marked degree in limestone areas, as the soil-covering in this case consists of the insoluble particles of limestone forming but a small portion of the original rock, mixed, perhaps, with organic matter. This solvent action of rain-water is attributed mainly to the various acids it holds in solution. The atmosphere likewise contains small quantities of acid which promote rock decomposition. The roots of plants pressing against rocks help to remove portions of the latter by solution. Even on bare rock surfaces it is found that bacteria and other low forms of plants exert considerable influence in promoting rock-decay.

Certain iron-bearing minerals found in rocks tend to break down as they unite with water and the oxygen of the atmosphere. This oxidizing process, or rusting, is especially true of rocks which contain a large proportion of iron-bearing minerals, and the more porous the rock is the more rapidly will oxidation take place. Another chemical agency which is important in promoting rock decomposition is hydration or the assumption of water by rocks. The effects of hydration are noticed hundreds of feet below the surface of the earth and rock masses increase in size proportionally as they chemically unite with the underground waters.

These are the processes which operate in breaking up rocks and making them suitable as supports for vegetation to take root and flourish. As soon as these destructive forces have furnished rock-débris sufficient for the larger plants to thrive, the soil-forming processes are greatly aided by the decay of the roots and other portions of the plant. Small forms of animal life also help to enrich and build up the soil.

Many of the forces, however, which have been enumerated as

operative in forming arable soils from rocks are, moreover, the agents by which the soil covering is removed and it is found that a sort of equilibrium is maintained between the forces which produce the soils and those that destroy them.

EXTERNAL AND INTERNAL CONDITIONS OF THE SOIL.

From an agricultural point of view, a soil is of value only when it is capable of bringing to the farmer a sufficient return for the money or labor that he has bestowed upon it. The capacity of a soil to produce plant growth not only depends upon the conditions within the soil, but also upon the conditions surrounding it. The soil itself must be of such a degree of fineness that the roots of plants may penetrate it and allow the rain-water to enter so that it may be utilized by the growing plant. The soil must also be permeable to air or its productiveness will be greatly diminished. The soil, moreover, must furnish the various elements which are essential to the growth of the plant, and to this end these elements must be present in the soil in an available condition. The proper temperature conditions must be maintained, that is, the soil must be able to store up the heat of the sun's rays in the daytime and give them out at night to prevent the serious effects due to sudden change of temperature. These are some of the internal conditions which affect the fertility of soils.

The views concerning soil fertility, however, have changed considerably during the last few years. Formerly it was supposed that their chemical composition was the controlling factor in the productiveness, but more recent investigations show that the temperature and moisture conditions which are dependent to a great extent upon the physical condition of the soil itself determine its fertility.

The external conditions which modify the agricultural value of the soil can be mentioned only briefly in this connection. Climate is probably the most important factor, and this depends on latitude, elevation above sea-level, nearness to the sea, general configuration of the country, and the direction and character of the winds. The local topography is also an important factor. The methods employed

in cultivation, the adaptability of the soils to certain special crops, and the relative amount of cleared areas exert considerable influence upon the agricultural value of the soils of any region. The distance from market and transportation facilities must also be considered.

From an agricultural standpoint Allegany county does not compare favorably with the other counties of the state, as its prominence depends almost wholly on its mineral resources. The surface of the county is rough and broken, consisting mainly of a series of long ridges separated by steep-sloped, narrow valleys. The growing seasons are short with hot days and cool nights and the winters are long and severe. The soils themselves do not possess any considerable degree of fertility, so it is readily seen that the conditions in the county are not favorable for any great agricultural advancement to be made without a large expenditure of energy and perseverance.

The principal agricultural products of the county are corn, oats, rye and potatoes. Small amounts of hay, wheat, fruit and buckwheat are also produced. Probably three-fourths of the county is still uncleared, and from the sale of timber in these wooded areas considerable income is derived. This is especially the case with sales of tan-bark and railroad ties in the eastern part of the county.

HISTORICAL SKETCH.

Comparatively little has been written concerning the soils of Allegany county. Probably the first one to attempt any scientific examination of them was Dr. James Higgins, who was State Agricultural Chemist from 1849 until 1859. Dr. Higgins visited various counties of the state, examined the soils and agricultural conditions and issued a series of reports, six in number, in which the results of his work are set forth. At a subsequent date, 1867, he published a volume in which the entire work was summarized. It is only in the Fourth Annual Report that Dr. Higgins has discussed the soils of Allegany county at any length. In his report he describes the important soil formations, publishes chemical analyses and recommends fertilizers and methods of cultivation for the different soils.

The soils which Dr. Higgins describes are the *Red Rock*, or *Red*

Sandstone soils, the *Limestone Clay* soils, the *Shaly Red Sandstone* soils, the *Potomac Bottom* soils, and the *Loamy* soils of the coal region. These names will be correlated with the present names in the descriptions of the separate formations, so that no further mention of them need be made in this connection.

In 1892 J. Thomas Scharf published in a popular form a book describing the natural resources and advantages of the counties of Maryland. In this paper mention is made of the soils and agricultural conditions of Allegany county. Scharf describes the soils of the county as sandy loams along the different streams, and loams mixed with limestone, slate and sand in the mountains.

In connection with the Maryland Agricultural Experiment Station and Johns Hopkins University, Professor Milton Whitney conducted scientific investigations of Maryland soils for a number of years. This work was carried on in 1891, and in 1892 Professor Whitney was made Chief of the Division of Soils in the U. S. Department of Agriculture. Since that time soil investigations have been carried on in the state under his personal direction and the present report on the soils of Allegany county is made under his supervision.

Professor Whitney's work on the soils of Maryland consisted of a classification of the soils of the state based upon the distribution of the geological formations and a series of investigations upon the physical properties of the soils themselves. As Physicist of the Maryland Experiment Station, Professor Whitney showed that the relation of the various soils of the state to the different crops depended upon their physical conditions rather than upon their chemical composition. A large number of experiments and examinations were made in which it was shown that the productiveness of the soil depends upon the moisture and heat conditions it maintains for the growing crop. An examination then of the texture and structure, or the physical condition in which the soil exists, explains in a satisfactory manner these essential conditions within the soil.

Several bulletins and reports were published in which the results of this work were set forth. The most important of these reports

which deal with the soils of Allegany county are the Fourth Annual Report of the Maryland Agricultural Experiment Station for 1891; Bulletin No. 4 of the U. S. Weather Bureau issued in 1892; Bulletin No. 21 of the Maryland Agricultural Experiment Station, published in 1893, and the chapter on Agriculture in Maryland: Its Industries, Institutions and Resources, prepared for the World's Fair in 1893.

In these reports Professor Whitney describes the soils derived from the Helderberg, Oriskany, Catskill, Hamilton, Niagara and Clinton formations. Chemical and mechanical analyses were published and many of their physical properties were discussed with reference to their productiveness. Professor Whitney's work will also be referred to in connection with the description of the separate soil formations.

SOIL FORMATIONS.

Any description of the various soils that are derived from the different rock formations in the county will show that there is a great similarity between certain of the soil-types. Thus it will be found that all the soils derived from fine-grained, homogeneous shales will have certain common characteristics. The soils derived from the different sandstone formations will also closely resemble each other in many particulars, while the soils derived from red sandy shales will be intimately related.

This only serves to emphasize what was stated at the beginning of this paper, that the soils of any given region closely resemble the rocks to which they owe their origin.

Since the climatic conditions are practically alike over the entire area of the county, mechanical analyses of the soil are of great importance in showing the texture of the soil. These explain in a very satisfactory manner the relations of the soil to moisture and to heat. A series of such mechanical analyses is given in the succeeding pages. Stated in general terms, the more clay a soil contains the more moisture will it hold, but the relative amounts of coarser grades of soil particles must also be taken into account. The term *clay* includes those particles of soil which have a diameter of from .0001 to .005 mm. without reference to their chemical composition.

Chemical analyses of the principal types of soils found in the county are also published. These chemical analyses were made by Dr. F. K. Cameron of the Division of Soils in the U. S. Department of Agriculture. In the following pages the different soils will be given according to the geological formation on which they rest and from which they have been derived.

THE JUNIATA.

The Juniata is so limited in its occurrence that the soils derived from its decomposition need only be mentioned. In the small area it occupies in The Narrows, west of Cumberland, the soil consists of heavy red sandy loams in which there is an admixture of shale fragments. No attempt is made at cultivation and but few trees find footing in the loose slipping mass of soil and undecomposed rock.

THE TUSCARORA.

The soils of the Tuscarora formation are also relatively unimportant. There are three areas in the county: Wills Mountain and the southern extension of Evitts and Tussey mountains. The occurrence of the formation as steep mountainous ridges is against its being of any great agricultural value. Probably in not one of the three areas where the formation occurs is it cultivated with the possible exception of the area at the base of Tussey's Mountain. Here there appears to be a considerable area of washed material from the slopes of the mountain which is partly cleared and cultivated, but in none of the other areas was a single cultivated field observed. In many places there are large areas devoid of soil-covering, while in other places, along the foot of Wills Mountain especially, there are huge piles of rock-talus.

The rock from which the soils of this formation are derived is a coarse quartz sandstone which is hard and massive and usually of a white or gray color. The soils partake very largely of the nature of the rock and consist of whitish sandy loams in which there is a slight amount of organic matter. The sandstone does not disintegrate readily, so that the soils are always shallow except in small pockets where they have accumulated.

Most of the area is strewn with large masses of the resistant gray sandstone. The average depth of the soil covering rarely exceeds 16 inches. As there are practically no cleared areas in the formation no idea can be gained of the productiveness of the Tuscarora soils. At present they only support a scant growth of pines and scrub oaks. The mechanical analyses of two samples of Tuscarora soils from Tussey's Mountain show a large percentage of sand with rather small amounts of silt and clay.

THE CLINTON.

The Clinton formation, like the Tuscarora, occupies only three small areas in Allegany county, two to the east and one to the west of Cumberland. From an agricultural standpoint, the area in the valley west of Flintstone is perhaps the most important. Each area occupied by the Clinton is rolling with broad, rounded hills and often local areas of bottom-land. The greater portion of its surface is cleared and cultivated, except in the area west of Cumberland on each side of Wills Mountain, where it is not farmed to any great extent.

The rocks of the formation consist mainly of brown and reddish shales, which are fine-grained and quite uniform in texture. In addition there are minor beds of limestone.

The soils of the Clinton are typical shale soils. They are shallow, of a light yellow or grayish color, and consist of fragments of undecomposed shale mixed with the finest particles of clay. These soils are light and easily stirred, but they do not retain moisture well and cannot be classed as strong soils, although they probably represent the best class of shale soils found in the county. Generally the surface soil contains a larger percentage of clay than the subsoil, which grades into gray undecomposed shale about 18 inches from the surface.

It is difficult to make these soils productive, for in bad seasons they dry out and fire the crops. Rye probably succeeds better than other grain crops, as from 12 to 15 bushels are produced per acre. In good seasons wheat does fairly well, and eight bushels per acre may be

considered an average yield. Oats, on account of the fact that they ripen late in the season, are much damaged by dry seasons. Corn, if it is planted early, yields fair crops, but otherwise it is not cultivated with profit. When the season is favorable enough to get a good stand of clover it lasts for two or three years, but much difficulty is usually experienced in getting it started. These lands before they are cleared are usually covered with a light growth of oak and pine.

In shale soils of this character any course of treatment is helpful which will deepen the soils and thereby increase their water-holding capacity. Deep plowing will effect this and heavy applications of stable manure will be beneficial. Applications of common salt have also been found useful on this class of soils in promoting the decomposition of the thin flat pieces of shale.

From the mechanical analyses of these soils, it is seen that the coarsest grades of sand are represented with fair amounts of silt and clay. In these analyses no account is taken of the shale fragments larger than 2 mm. in diameter. These form a large part of the soil and make it loose so that it is easily dried out.

THE NIAGARA.

The Niagara formation occurs in four well-defined areas in the county, very closely associated with the areas of the Clinton formation in their occurrence. It consists mainly of thin bands of limestone interbedded with fine-grained shales and is not very important from an agricultural standpoint on account of the relatively small area it occupies. The soils derived from the Niagara belong to the better class of those found in the county, and, though rather shallow, are usually quite fertile. They are yellowish loams containing considerable clay mixed with fragments of shale. They can largely be improved and oats, rye, grass and wheat succeed fairly well on them, but as in most of this region the yields per acre are not very large.

THE SALINA.

The soils of the Salina occupy pretty nearly the same areas as the Clinton shales, but the areas stand out usually as more pronounced

ridges than the broad low hills of the Clinton. The soils closely resemble the materials from which they are derived and they prove to be fairly productive. Occurring as they do in the same localities as the Helderberg limestone, it is interesting to compare the two classes of soils, and it is found that in good seasons they are nearly as productive as the heavier limestone soils.

The soils are brown or red in color, and although they contain some sand, they may be classed above the better grade of sandstone soils. They usually have a depth of about 22 inches. These soils are well drained and are heavy enough to hold moisture and are easily improved. Twelve bushels of wheat per acre can be raised and good yields of grass, corn, oats and rye are also raised with fair crops of each. They may be classed as wheat and grass lands.

The Salina soils can be cultivated profitably and may be considered among the better class of strong loam soils found in the county. By referring to their mechanical analyses, it will be seen that they are composed of the finest grades of sand with a good proportion of clay. The samples analyzed are all subsoils and in each case are heavier than the surface materials.

THE HELDERBERG.

There are four important areas of the Helderberg in Allegany county. Two of these occur as V-shaped areas east of Cumberland, while the other two extend across the county through and to the west of Cumberland.

The Helderberg, from its occurrence with the Oriskany sandstone, usually forms steep ridges which are held up by the more resistant Oriskany formation. In some of the areas of the Helderberg there are comparatively level stretches of country, but generally the formation consists of long, steep slopes presenting differences in elevation of several hundred feet.

The Helderberg is principally a limestone formation, although it contains beds of shales. The soils of the Helderberg may be described as strong and fertile, although they may not have any great depth. They probably rank as the best in the county, and the better

class of these limestone soils will compare favorably with the best agricultural regions of the state.

These soils, as distinguished from the subsoils, are usually red or yellow heavy loams, while the subsoils are generally strong red or yellow clay loams. They are stiff and firm and retain the moisture and are quite well adapted to grass and wheat. They are spoken of as natural Bluegrass lands. Timothy does very well upon them, giving one and one-half tons per acre, while fifteen bushels of wheat per acre is an average yield. Corn is not raised to any great extent because the continual cultivation in the spring and summer is apt to leave the field in a condition to be easily washed and furrowed by gullies. It is customary to keep the fields protected as much as possible to prevent washing. Oats, rye and clover succeed quite well.

While the Helderberg soils are generally strong and fertile there are some areas where they are poor and unproductive. This is especially true in the case of the soils derived from the cherty members of the Helderberg. These are light and shallow and filled with pieces of cherty limestone. Rye and potatoes do fairly well, but the other crops generally grown in this region do not succeed. These soils are sometimes spoken of as limestone gravel soils and they are well adapted to the growth of peaches, grapes and small fruits. There are some very successful orchards on the south and southeast slopes of these cherty areas.

There is a considerable area of limestone soil in the valleys along the Potomac river southwest of Cumberland in the region about Black Oak Bottom Station. Here the soil is deep, but it is not as productive as might be expected from the favorable location. This is doubtless due to the fact that there is need of underdraining, for the ground receives the drainage from the hills and is apt to be too wet and spouty.

Dr. Higgins has named these the Clay Limestone soils and described them as dark loams with a tough reddish clay subsoil. The difference in their fertility he ascribes to the greater abundance of phosphoric acid in some localities than in others. Professor Whitney, in the reports mentioned, called them the Helderberg Limestone

soils and describes them as strong yellow clay soils which are naturally well drained and capable of a high state of cultivation. They are uniform in texture and well adapted to grass and wheat. The chemical analysis of this soil which he published gives but little clue to its productiveness.

The mechanical analyses of the Helderberg show only small amounts of sand while the bulk consists of silt and clay. The analyses of these soils easily explain their strength and productiveness. The analysis of the cherty sample is quite similar to the analyses given of the Clinton shale soils. The samples which contain the greatest amounts of clay are usually considered the strongest and most valuable.

THE ORISKANY.

The Oriskany formation occupies a large area in the center of the county and two or three minor areas in the western part. The formation includes most of the mountainous ridges and the intervening valleys in the center of the county, and in the other areas where it occurs it forms long narrow ridges with the Helderberg. The formation, although it occupies quite a large area in the county, is not important from an agricultural standpoint. The rocks of the Oriskany are described as coarse, white, friable, slightly calcareous sandstones.

The soils derived from the disintegration of the Oriskany are usually shallow sandy loams with a small percentage of organic matter. They are gray or yellow in color, and over most of the area there is a covering of gravels and boulders ranging in diameter from a few inches to several feet.

Along the lower levels of this area the soil is usually a heavier loam, but along the summits of the mountains the soil consists of a very shallow covering of sandy loam mixed with large boulders and masses of rock. In some parts of the area the rock surfaces are bare of soil-covering, with here and there an occasional pine tree which finds footing in the rock crevices. By far the larger part of the area is uncleared and covered with a light growth of pines and oaks. Where the Oriskany is cleared it is found that rye and potatoes sue-

ceed better than other crops, although corn, oats and clover do reasonably well for such light sandy soils. Along the higher parts of the mountains the soils are warm and dry and fair crops of corn are raised on fields where the soil covering seems only to consist of a loose mass of white sandstone fragments. There is no doubt that peaches, grapes and small fruits would succeed on the protected slopes of these rocky areas, but up to the present time no attempt has been made to introduce them.

In the Fourth Annual Report of the Maryland Agricultural Experiment Station, Professor Whitney has described these soils as lacking uniformity in texture and naturally poor, but capable of some improvement. He has classed them as Mountain Pasture Soils.

THE ROMNEY-JENNINGS.

The Romney-Jennings formation probably occupies the largest area in Allegany county. Most of the eastern part of the county consists of these two formations, and there are two good-sized areas in the western part. The Romney-Jennings are two distinct geological formations, but the soils are so nearly alike that they can be described together.

In the eastern part of the county the surface is rolling with one or two rather prominent ridges. In the other areas there is considerable rolling upland with some bottom-land. The rocks of these formations are fine-grained shales with minor beds of sandstone. Thin bands of limestone occur as well as beds of coarse conglomerate.

The soils derived from these two formations are quite uniform over the entire area. They are shallow soils with an average depth of about 18 inches and possess little agricultural value, and where uncleared there is a light growth of pine and oak. In some areas of the formation, however, especially in the eastern part of the county, there are some farms which have been considerably improved and produce fairly well.

The color of these soils is grayish and yellowish and they contain a large proportion of shale. On the steep slopes the soil particles are washed away nearly as fast as they are formed, so that often these

slopes are only covered with a slight layer of shale fragments. These soils are rather typical shale soils and quickly dry out and fire the crops. Rye and oats do fairly well and corn is profitable if it is planted early. Seven bushels of wheat, fifteen bushels of oats and from fifteen to twenty-five bushels of corn per acre are said to be average yields on the Romney-Jennings. Such soils need to be carefully treated and will not stand hard farming. Many of the slopes in this area that are cultivated should be allowed to grow up in forest or else they will soon be swept clear of soil-covering. Some of the angles of the steepest of these slopes were measured and found to be as high as 40° .

Deep plowing would be beneficial to these soils; turning under green manures and stable manures would also increase their water-holding capacity. Applications of common salt have also been found to be useful on these soils in promoting the decay of the shale fragments contained in the soil.

Dr. Higgins and Professor Whitney have both described these soils. Dr. Higgins calls them the Red Shaly Sandstone soils and states that their great disadvantage is their shallowness and the injury they receive from washing. Professor Whitney described them as Mountain Pasture Lands. They are naturally poor, he states, but are capable of some improvement. They consist of fine-grained powdery material with fragments of the original rock. Mechanical analyses of these soils show them to be composed principally of the finest grades of sand and silt.

THE HAMPSHIRE.

The Hampshire occurs in the eastern part of the county and again along the eastern slope of Dans Mountain in the western part. In both areas the formation is hilly with steep slopes, although there is a small amount of level upland. The rocks of the formation are red and brown shales and fine sandstones.

The soils of the formation are not important in Allegany county, although they are quite valuable farm lands in Garrett county. Only the area in the eastern part of the county is farmed to any extent, as

the area on the eastern slope of Dans Mountain is uncleared, and there are no wagon-roads leading to it with the exception of two or three wood-roads. The soils are red and brown sandy loams with a scattering of flat shaly rocks on the surface. These soils grade from a typical shale soil to a rather heavy type of sandstone soil which produces fairly well. The shale soils are shallow, sandy soils which wash badly and are hard to improve. The areas of the heavy type of Hampshire soils are small and are derived from the fine-grained sandstone members of the formation.

The Hampshire soils produce an average of about 12 bushels of wheat, from 15 to 20 bushels of corn and about 20 bushels of oats per acre. Grass holds fairly well and these soils make fair pasture lands. They are more productive than the Romney-Jennings soils, although the analyses of samples from the eastern part of the county do not show as large percentages of clay as the Romney-Jennings contain. The greatest part of the soil, according to the analyses given, consists of very fine sand and silt.

Dr. Higgins describes these soils as the Red Sandstone soils and states that they belong to the class known as quick soils. He also states that they are light and porous and do not suffer from drought and moisture. Professor Whitney in his description states that they are good strong lands adapted to grass and wheat.

THE POCONO.

The Pocono forms the capping of Town Hill Mountain in the east of the county and a line of foothills along the east front of Dans Mountain in the western part. Neither of these areas is of any value for farming purposes, although there is some attempt at cultivation in the eastern part of the county. The rocks from which the Pocono soils are derived are hard, thin-bedded flaggy sandstones and the soils closely resemble the parent rock. They are sandy with a slight mixture of vegetable material. These soils rarely exceed 10 inches in depth and they are probably the poorest soils in the county. They are hard to cultivate on account of the fragments of rocks in the soil and the boulders which are strewn over the surface. They consist almost entirely of sand with small amounts of silt and clay.

THE GREENBRIER-MAUCH CHUNK.

The only area of Greenbrier-Mauch Chunk in the county lies in a slight depression between the outlying ridge of Pocono sandstone and the eastern front of Dans Mountain. The area is almost entirely forested and is difficult of access. The rocks of these two formations are grayish limestones with red and brown shales and sandstones. The soils are usually loams which are capable of being improved and cultivated with profit. Often, however, there is difficulty in getting rid of the huge boulders which come down the mountain side from the Pottsville formation. These soils are not deep but are heavy enough to retain moisture, and they closely resemble the better class of Hampshire soils.

The formations included in the Coal Measures occupy the entire portion of the county west of Dans Mountain known as Georges Creek Valley. The surface of the valley is hilly but there is some level upland. Considerable of the area is cleared and one is surprised that not more of the better class of land is cultivated. The soils are derived from several formations and each one will be briefly described. These soils all closely resemble one another and consist of a series of loams ranging from light sandy loams to heavy loams.

THE POTTSVILLE.

The Pottsville forms the capping of Dans Mountain and is practically valueless from an agricultural standpoint. The soils range from heavy loams of a good depth to only a shallow covering of coarse sandy loam strewn with huge masses of sandstone. But little of the area is cleared and it is usually covered with a light growth of oak, chestnut and hickory. Where cultivation is practiced, however, fair yields of buckwheat, rye and oats are harvested.

THE ALLEGHENY.

The Allegheny formation occurs on both sides of Georges Creek Valley as a series of outlying hills and slight depressions between the hills and the mountain tops. There is quite a large proportion of cleared land in the area and much of it could be farmed with profit.

There is only a slight amount of it cultivated, however, as the people of the valley depend entirely upon the coal mines for a livelihood rather than upon farming.

The rocks from which the soils of the Allegheny formation are derived are mostly sandstones with small beds of sandy shales. The soils are yellow loams of no great depth, but they could easily be improved and made profitable farm lands. At present they are mostly used for pastures, although oats, rye, buckwheat and potatoes are raised. In some areas where this formation occurs the surface is strewn with boulders and rock masses, although small pieces of flaggy sandstone are mixed with the soils.

In the depressions, or "Sags," between the outlying hills and mountain tops the drainage is poor and swamps result. The soils in these areas are usually coarse, sandy soils, quite shallow and contain a large percentage of organic matter. None of these areas are cultivated and underbrush, mosses and ferns grow abundantly. Oats, rye and buckwheat are probably the only staple crops which could be farmed with profit on these cold, swampy soils. From the analyses it is seen that they are composed principally of sand and silt.

THE CONEMAUGH.

The Conemaugh, in the northern part of Georges Creek Valley, embraces some of the best farming land of the valley. In the Conemaugh there is more of an attempt to cultivate the land than in any of the other formations of the area. The soils derived from the disintegration of the Conemaugh shales and sandstones are probably not much better than those of the Allegheny. They consist of yellow shaly loams about 18 inches in depth. These soils, like those of the Allegheny formation, are adapted to oats, rye, potatoes and buckwheat.

THE MONONGAHELA.

The Monongahela occupies the center of Georges Creek Valley and the soils are similar to those already described as occurring there. They are not uniform in texture and may range from a leachy, gravelly soil to heavy dark loams. Considerable of the area is cleared and

only those crops raised which are most valuable for local purposes. Rye is grown especially for the straw, and as much hay is made as is possible to supply the mules which work in the mines. Much of the area is devoted to gardens by the miners. Over most of the area the soils are yellowish loams about 18 inches in depth.

THE DUNKARD.

The Dunkard occurs in the central portion of the valley capping the hills in the vicinity of Lonaconing and Frostburg. The soils closely resemble the other soils of the area. They consist of sandy and clay loams, yellow in color and rarely exceed 20 inches in depth. They are not cultivated to any great extent. Oats, corn, rye and potatoes are grown upon them, but the yields are not very large.

ALLUVIAL SOILS.

The alluvial soils found in Allegany county include those areas of river-deposited sediment found along the principal streams of the county. Such soils vary greatly in texture, composition and agricultural value, depending largely upon the size of the streams and the materials from which these soils are derived. These soils belong to the pleistocene period, although many areas of alluvial soils are still in process of formation and are subject to change with the overflows of the various streams along which they occur. The area southwest of Cumberland, on the North Branch of the Potomac river, is probably the most important area found in the county and many large and prosperous farms are located there. Along Evitts Creek and the Potomac at North Branch Station there are large areas which are profitably cultivated, while many areas of less importance are found along the smaller streams of the county.

In the areas mentioned the soils vary in texture from gravelly loam, composed of large rounded gravel mixed with sand and clay, to heavy clay loams which are derived from the decomposition products of shaly limestones and fine-grained sandstones. Alluvial soils are usually regarded as fertile soils on account of the rather high percentage of organic matter they contain and the thorough mixture of the various rock particles which compose them.

The soils in the valley southwest of Cumberland and along Evitts Creek are mainly derived from the wash of limestone hills and closely resemble rich fertile soils derived from pure limestone. These soils, from their position, rarely suffer from drought in dry seasons, and therefore are well adapted to grass and corn, while wheat does fairly well on the better drained bottom-lands. Many of these soils suffer from the lack of underground drainage, and thorough drainage should be the first step in their cultivation. Wheat on these heavy lands has a tendency to disease and makes a coarse, rank growth of straw, while grass succeeds quite well and large crops are made every year.

Along the larger streams the distinction between first and second bottoms is made. The first bottom usually refers to the lowest land lying along the stream, while the second bottom refers to a distinctly higher terrace sloping gradually back to the hills. The first bottoms are usually considered the better, although the crops are subject to overflow during almost any season of the year. The second bottoms are generally "spouty" or "springy," and during the spring and early summer they are apt to be wet and unfit for cultivation.

Alluvial soils which are subject to overflow may have thick deposits of sand or gravel left upon them in times of high water, or the rich fertile loam may be entirely swept away during times of flood. Along the smaller streams there may be small, local areas where the streams have cut wide valleys. Such areas make good farm-land, but generally along the small streams the deposits consist mainly of coarse sand, gravel and even masses of huge boulders. These coarse deposits are of little or no agricultural value.

MECHANICAL ANALYSES OF SOILS AND SUBSOILS FROM ALLEGANY COUNTY.

No.	Locality.	Description.	Moisture in air-dry sample.	Organic matter.	Gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Fine silt.	Clay.
			Per ct.	Per ct.	2-1 mm.	1-5 mm.	.5-.25 mm.	.25-1 mm.	.1-.05 mm.	.05-.01 mm.	.01-.005 mm.	.005 mm.
TUSCARORA.												
3481	W. slope of Tussey's Mt. . .	Uncleared . . . . .	.85	1.97	3.93	5.16	13.70	20.61	9.86	22.62	5.42	16.62
3700	S. slope of Tussey's Mt. . .	Uncleared	1.00	3.30	.82	3.70	15.07	22.17	14.73	17.67	5.53	15.02
CLINTON.												
3483	1 mi. W. of Flintstone	Rye, oats, corn, wheat 10-18"	1.44	5.42	7.32	6.00	3.49	2.90	9.05	31.49	9.51	21.91
3482	Flintstone Valley	Oats, rye, corn.	1.51	7.87	15.50	10.57	4.82	3.57	6.80	15.61	10.96	24.24
3702	E. of Whitts Mt.	Rye, oats, corn.	1.54	4.62	8.76	8.30	4.11	4.30	10.38	18.00	13.63	26.00
SALINA.												
3488	S. W. of Cumberland	Corn, wheat, oats	1.42	2.68	.40	1.55	4.52	13.33	18.29	23.81	6.52	26.25
3485	W. of Flintstone	Oats, rye, grass, wheat 8-18"	1.51	3.77	4.07	3.51	3.43	3.66	10.83	33.74	8.33	27.10
3705	N. W. of Flintstone	Wheat, corn.	1.06	4.00	3.20	4.78	4.08	4.40	25.15	12.90	8.30	31.78
HELDREND.												
3707	W. of Cumberland	Rye, corn, potatoes. . .	.99	5.06	7.80	5.85	4.08	5.35	17.75	23.98	12.37	16.11
3491	N. W. of Twiggstown	Grass, wheat	1.66	4.80	trace	1.43	1.10	3.37	13.63	32.33	15.50	26.15
3492	Twiggstown	Grass, wheat	1.87	4.30	.25	.80	1.20	3.76	12.84	37.15	7.98	29.22
3495	Black Oak Bottom	Grass, wheat, corn . . .	1.57	3.86	trace	1.35	2.90	8.07	19.19	26.39	6.40	30.21
3493	5 mi. E. of Cumberland . . .	Uncleared	3.17	4.28	.36	.43	.62	.76	24.61	22.87	4.95	38.52
3490	Flintstone	Grass, wheat	2.74	5.26	.75	1.10	1.62	2.92	8.60	26.11	8.33	42.01
3709	W. of Whitts Mt.	Grass, wheat, corn. . .	4.58	5.21	. .	1.17	.67	1.18	23.07	9.57	6.32	48.00
ORTSKANY.												
3497	E. of Cumberland	Corb, rye, potatoes. . .	.47	1.54	1.38	2.43	7.19	41.72	23.14	9.89	2.95	8.39
3496	E. of Cumberland	Uncleared . . . . .	.66	2.32	3.25	5.95	9.21	20.40	24.17	19.79	5.16	9.38
3499	Marlins Mt.	Rye, oats, potatoes. . .	.66	2.64	3.57	3.77	7.12	26.07	27.08	14.20	3.61	10.35
3710	E. of Warrior Mt.	Uncleared . . . . .	.47	2.72	1.00	3.25	9.38	13.91	13.10	22.52	12.63	20.93
3501	6½ m. N. E. of Cumberland	Clover, rye, potatoes. .	1.42	3.50	1.81	2.57	3.41	9.90	16.71	29.08	7.97	22.22
ROMSEY-JENNINGS.												
3504	1 mi. N. W. of Patterson Ck. .	Grass, wht., corn, oats 0-8 "	1.22	4.02	1.21	1.62	2.19	9.63	32.23	24.07	6.46	17.37
3510	W. of Frostburg	Oats, grass, wht., corn 0-8 "	1.89	7.00	.98	.95	1.39	10.32	24.67	26.13	7.82	19.00
3505	1 mi. N. W. of Patterson Ck. .	Grass, oats, wht., corn 8-14"	3.21	3.23	1.20	1.43	2.50	12.01	30.41	21.85	6.02	19.04

MECHANICAL ANALYSES OF SOILS AND SUBSOILS FROM ALLEGANY COUNTY. — *Continued.*

No.	Locality.	Description.	Moisture in air-dry sample.	Organic matter.	Gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Fine silt.	Clay.
			Per ct.	Per ct.	2-1 mm.	1-5 mm.	.5-.25 mm.	.25-1 mm.	1-.05 mm.	.05-.01 mm.	.01-.005 mm.	.001 mm.
3507	ROMNEY-JENNINGS.	Corn, grass, oats, wht. 8-26"	1.08	2.47	3.40	1.90	.88	2.48	15.56	39.97	9.94	21.87
3508	2½m. W. of Paw-Paw, W. Va.	Corn, grass, wht., oats 0-12"	1.97	7.07	6.45	5.36	3.66	3.18	6.17	34.04	11.31	22.22
3511	E. of Flintstone.....	Oats, corn, grass, wht. 8-26"	1.40	3.53	2.33	2.84	2.61	11.80	23.49	21.60	8.15	22.22
3509	Western part of county....	Uncleared..... 12-20"	1.52	6.15	9.35	5.39	2.50	2.00	11.75	24.46	13.56	23.72
3502	Gilpin.....	Corn, grass, wheat... 0-8 "	1.48	4.55	.78	1.40	2.21	3.56	7.92	38.17	11.35	27.81
3503	Gilpin.....	Corn, grass, wheat... 8-26"	2.29	3.31	..	.53	3.32	7.25	9.42	23.77	8.45	40.27
3521	HAMPSHIRE.											
3521	Eastern part of county....	Composite sample, ... 0-8 "	1.00	4.44	2.88	2.31	1.47	7.85	20.69	35.57	7.22	16.87
3522	Eastern part of county....	Composite sample, ... 8-22"	.93	3.07	3.03	3.06	2.91	11.66	19.88	30.41	6.25	19.02
3537	POCONO.											
3537	Town Hill Mt.	Uncleared, C. S. 8-12"	1.05	3.60	1.16	3.64	24.01	31.89	12.10	12.24	2.75	7.51
3723	GREENBRIER-MAUGH CHURK											
3723	3½m. S. W. of Cresaptown.	Uncleared..... 0-14"	1.42	5.53	3.31	4.48	3.47	4.52	14.29	26.50	11.39	24.23
3724	POTTSVILLE.											
3724	4m. W. of Cresaptown....	Uncleared..... 0-15"	1.57	5.12	3.27	3.09	3.34	6.79	18.72	17.04	6.88	23.00
3573	ALLEGHENY.											
3573	Allegheny county.....	Grass, oats, buckwht. 12-28"	1.81	3.85	5.88	8.57	8.10	6.83	10.32	26.73	7.18	19.66
3557	Allegheny county.....	Uncleared and swampy 0-12"	2.22	8.11	1.44	2.32	4.40	7.15	15.10	25.98	10.39	21.87
3576	CONEMAUGH.											
3576	Georges Creek Valley.....	Corn, oats, rye, potatoes 0-10"	2.54	9.00	2.92	2.49	2.00	3.67	15.30	27.81	12.56	22.00
3591	Allegheny Station.....	Grass, corn, rye..... 8-14"	1.33	1.84	1.12	.86	1.41	9.50	17.05	32.23	8.40	27.57
3588	MONONGAHELA.											
3588	E. of Frostburg.....	Rye, oats, grass..... 8-16"	1.40	5.60	3.51	3.96	5.66	28.17	15.68	16.72	6.33	12.91
3585	E. of Frostburg.....	Rye, oats, grass..... 0-8 "	5.64	16.30	.95	3.20	5.22	11.09	9.90	14.31	6.26	26.57
3586	E. of Frostburg.....	Rye, oats, grass..... 8-26"	1.61	5.25	trace	2.70	4.37	11.99	17.12	17.08	7.42	32.11
3597	ALLUVIAL.											
3597	N. Branch Station.....	Corn, wheat, oats.... 8-40"	1.07	3.74	1.60	2.05	3.11	15.23	30.57	21.94	4.11	16.16
3595	Everts Creek Bottom.....	Grass, wheat, corn... 10-20"	1.29	3.66	2.78	3.41	5.45	8.25	13.63	32.75	7.70	20.47

SUMMARY OF THE MECHANICAL ANALYSES OF SOILS AND SUBSOILS FROM ALLEGANY COUNTY.

Number of samples.	Formation.	Description.	Moisture in air-dry sample.		Organic matter.	Gravel.		Coarse sand.	Medium sand.		Fine sand.		Very fine sand.		Silt.	Fine silt.		Clay.
			Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.
1	Pocono	Shallow stony soils	1.05		3.60	1.16	3.64	31.89	24.01	31.89	12.10	12.24	2.75	7.51				
5	Oriskany	Shallow stony soils .....	.73		2.52	2.20	3.59	22.40	7.40	22.40	20.84	19.09	6.46	14.05				
2	Tuscarora	Shallow stony soils .....	.93		2.64	2.38	4.43	21.39	14.34	21.39	12.29	20.19	5.48	15.12				
2	Hampshire	Red shaly loams .....	.96		3.75	2.95	2.68	2.19	2.19	9.75	20.28	32.99	6.73	17.85				
2	Alluvial	River bottom loams	1.18		3.20	2.19	2.73	11.74	4.28	11.74	22.10	27.34	5.90	18.32				
2	Allegheny	Shallow yellow loams	2.02		5.98	3.66	5.95	6.25	6.25	6.99	12.71	26.39	8.78	20.76				
1	Pottsville	Shallow rocky loams	1.57		5.12	3.27	3.09	3.34	3.34	6.79	18.72	17.04	6.88	23.00				
9	Romney-Jennings	Shallow shale soils	1.76		4.66	2.86	2.38	2.37	2.37	6.91	16.96	28.22	8.12	23.72				
3	Monongahela	Yellow loams	2.88		9.05	1.48	3.29	5.05	5.05	17.08	14.23	16.04	6.66	23.86				
3	Clinton	Thin shale soils	1.46		5.97	10.52	8.29	1.13	1.13	3.59	8.81	22.38	11.70	24.05				
1	Mauch Chunk-Greencbrier ..	Red shaly loams	1.42		5.53	3.31	4.48	3.47	3.47	4.52	14.29	26.50	11.39	24.23				
2	Conemaugh	Yellow shale loams	1.94		5.82	2.02	1.68	1.70	1.70	6.58	16.17	30.52	10.58	24.78				
3	Salina	Heavy red loams	1.33		3.45	2.56	3.28	4.01	4.01	7.13	18.09	23.48	7.72	28.38				
7	Helderberg	Fertile clay loams	2.38		4.08	1.31	1.73	1.74	1.74	3.60	17.09	25.17	8.86	32.90				

THE CLIMATE OF ALLEGANY COUNTY

BY

OLIVER L. FASSIG

INTRODUCTION.

So variable are the elements of the weather in an inland region in our latitudes that many years of continuous observations of temperature and rainfall are required to obtain an accurate average value.

To obtain a value for the mean annual temperature correct within 1° Fahrenheit requires from twenty to thirty years of daily observations. In the tropics near the ocean, where weather conditions are more uniform, an equally accurate value may be obtained from four or five years of observations.

Alleghany county is particularly fortunate in the possession of a long series of valuable observations of climatic conditions. One of the first objects to claim the attention of Professor Joseph Henry, after the establishment of the Smithsonian Institution in 1849, was the organization of an extensive network of stations for recording weather conditions, and collecting facts for the study of American storms. Professor Henry soon succeeded in enlisting the services of a devoted body of intelligent observers. Among the early and faithful members of this system was Mr. Edwin Thomas Shriver of Cumberland. Mr. Shriver began the daily reading of the thermometer, and his observations of wind and weather, in January of 1859. With splendid persistence, and with the true spirit of devotion to science, he continued his daily observations uninterruptedly for thirty-seven years. In 1871 the measurement of rainfall was added to his record. The last report of Mr. Shriver, for January, 1896, made a month before his death, was as complete as those of his early days. Few individual records of the weather in this country can compare with

those of Mr. Shriver in completeness and continuity. But two records in Maryland are longer. Frederick has a continuous record from about 1821, but made by numerous observers; Baltimore has a record, though not entirely continuous and made under different auspices, beginning in 1817. To Cumberland belongs the distinction of having the longest continuous record in Maryland made by a single observer.

The topography of Allegany county is described in detail elsewhere in this volume. It is desirable here to bear in mind only the most general topographic features. The county is in the heart of the Alleghany mountain system; its surface is made up of parallel ranges rising in places to elevations of nearly 3000 feet, and extending northeast and southwest. The valleys are narrow. The population of the county is mostly in the valleys, largely along the Potomac river, at elevations varying between 700 feet and 1000 feet above sea-level. Cumberland, Boettcherville, Westernport, Flintstone, and Oldtown are all under 1000 feet elevation and have approximately similar climatic conditions. The annual and monthly values for temperature and rainfall at all of these stations, as shown by accompanying tables, agree very closely with the normal values obtained from Mr. Shriver's long record for Cumberland, after making due allowance for the short periods of observation. The climate of Cumberland represents very well the climate of the valleys of Allegany county.

Climatic conditions change rapidly with change in elevation. In round numbers the mean temperature falls 1° Fahrenheit for every 300 feet in elevation above the surface of the earth. A similar fall in the mean temperature is experienced, at sea-level, in the Middle Atlantic states, by traveling northward about 40 miles. To state the same fact in another way: Frostburg, at an elevation of about 1500 feet above Cumberland, should have a mean annual temperature of about 5° Fahrenheit less than that at Cumberland, or about 48° . A similar fall in the mean annual temperature is met with in going northward from Cumberland, across the state of Pennsylvania, into the southern portions of New York state.

At the present time we have but little over one year's observations for Frostburg, a period totally inadequate to establish a reliable mean value for the annual temperature. The mean annual temperature obtained for the period from September, 1898, to August, 1899, is 50.7° Fahrenheit. During this period the temperature at neighboring stations was about 1.5° above normal; subtracting this amount from 50.7° , we have 49.2° as a closer approximation to the normal value for Frostburg. Probably a still more accurate value would be the mean for five years of observations made at the neighboring station of Grantsville, in Garrett county, which has about the same elevation as Frostburg and is but a few miles to the north. This is 48° .

TEMPERATURE.

The climatic factor of most concern to us, viewed from the standpoint of personal comfort, is the variability of the temperature in our vicinity. In tables and diagrams here presented, may be found the average annual and monthly values for all stations established in Allegany county, the mean daily variation, the mean monthly variation, and the absolute extremes of temperature. In Table I may be found the results of Mr. E. T. Shriver's extremely valuable record of the temperature at Cumberland for thirty-seven years. The normal mean temperature for the year is 51.5° ; the annual average has varied between the limits of 49.1° in 1867 and 54.6° in 1893. The mean monthly temperatures have a range varying from 18° during the winter months to less than 10° during the summer months. January is the month of greatest variation, with February a close second, while August is decidedly the month of least variation.

Table II presents the mean monthly and annual temperatures for each station in Allegany county at which observations have been made during a period of one year or more. The average daily range, the average monthly range, and the absolute maximum and minimum values are also shown. In the valleys the average daily range of temperature is about 24° , at Frostburg the average daily range is but 21° .

TABLE I.—MONTHLY AND ANNUAL MEAN TEMPERATURES
AT CUMBERLAND FROM 1859-1895.

RECORD OF E. T. SHRIVER.

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1859..	31.4	34.9	41.8	45.3	62.0	67.4	70.8	69.1	63.5	50.6	43.5	34.3	51.3
1860..	33.4	31.7	43.3	50.4	64.1	68.4	70.4	68.6	59.7	50.7	42.8	33.3	51.6
1861..	30.6	34.7	41.5	48.3	55.5	71.8	72.6	72.6	64.8	55.5	44.5	34.7	52.3
1862..	32.9	32.2	36.4	46.0	57.7	69.6	72.4	70.8	59.4	53.8	42.0	33.1	50.5
1863..	31.2	31.3	34.5	48.4	58.4	66.4	74.8	73.4	59.2	51.3	43.1	33.8	50.5
1864..	30.3	32.2	35.2	46.1	62.7	70.6	70.5	74.0	70.9	50.6	42.3	33.0	50.7
1865..	22.4	31.2	41.7	50.6	56.5	74.9	74.3	69.6	71.0	48.2	41.6	34.0	51.3
1866..	31.4	27.9	37.3	51.4	53.9	71.1	72.5	67.0	64.4	51.4	40.9	27.5	49.8
1867..	22.4	31.7	36.3	49.0	54.0	69.9	70.9	69.9	62.5	48.0	42.9	30.8	49.1
1868..	28.2	22.4	28.5	48.8	58.4	69.8	75.2	69.7	62.3	48.9	41.2	30.7	49.7
1869..	36.4	35.0	36.4	47.6	58.4	68.5	70.5	71.0	62.0	45.8	36.3	33.8	50.3
1870..	36.1	32.7	36.0	49.2	59.4	69.3	75.3	70.7	62.9	53.4	41.2	32.0	50.3
1871..	28.2	30.7	41.4	49.5	62.0	69.2	73.6	75.7	61.1	54.1	40.5	30.5	51.4
1872..	30.2	31.4	33.2	51.8	63.9	72.0	76.6	75.7	66.4	52.6	38.8	27.9	51.7
1873..	28.7	32.3	38.0	51.7	61.5	72.3	74.0	71.2	64.3	52.9	39.0	37.6	51.9
1874..	36.0	36.1	41.4	45.0	62.0	74.0	74.4	69.6	67.0	53.0	40.0	35.0	52.8
1875..	29.0	25.2	30.0	47.0	63.0	71.0	72.0	69.0	63.0	52.0	40.0	37.0	49.8
1876..	38.0	35.3	36.5	49.0	62.0	73.0	76.0	73.0	62.0	49.0	41.0	29.5	52.0
1877..	30.0	38.0	37.5	51.2	59.5	69.0	73.0	70.0	63.0	55.0	41.6	40.0	52.3
1878..	29.0	36.0	46.0	55.0	59.0	65.3	76.4	74.0	64.0	53.0	42.0	28.0	52.3
1879..	27.0	27.2	39.0	50.0	62.0	67.0	74.0	69.0	60.0	59.0	41.0	37.0	51.0
1880..	39.0	36.2	38.5	53.0	67.0	69.0	71.0	70.0	63.0	50.0	35.0	26.0	51.5
1881..	25.0	27.5	37.0	57.6	65.0	67.5	73.5	75.0	70.0	60.0	43.0	33.5	52.9
1882..	33.3	37.9	42.7	50.5	57.0	69.1	71.4	69.0	65.0	55.8	41.0	31.2	52.0
1883..	37.0	33.4	35.0	48.0	62.5	69.9	72.9	68.5	62.3	53.9	44.7	36.0	52.0
1884..	26.6	36.3	40.8	49.6	61.4	68.7	70.5	70.0	68.0	56.8	41.9	33.2	52.0
1885..	29.0	25.9	33.1	50.4	60.0	68.8	74.5	70.0	63.0	51.0	42.6	35.4	50.3
1886..	25.0	29.9	40.2	54.8	61.4	67.2	70.8	70.5	65.3	54.2	41.1	29.1	50.8
1887..	28.6	36.4	35.0	49.2	65.8	69.6	77.7	70.2	62.0	50.0	39.8	32.9	51.4
1888..	26.6	32.8	35.7	50.3	60.2	70.2	70.3	69.2	59.3	48.0	42.8	33.6	49.9
1889..	34.7	28.0	41.9	52.8	62.9	67.2	73.6	69.2	64.0	49.5	41.8	43.2	52.4
1890..	40.7	40.0	36.3	51.8	61.4	72.6	73.9	69.8	63.2	52.7	44.3	31.8	53.2
1891..	33.2	38.0	35.9	54.2	60.9	70.1	68.7	70.5	67.1	51.5	40.9	39.6	52.6
1892..	30.0	34.5	35.7	49.3	62.3	73.3	72.9	75.2	64.0	52.6	41.0	31.6	51.9
1893..	25.3	32.8	42.6	55.3	64.3	75.1	77.7	74.0	66.0	56.7	44.6	40.6	54.6
1894..	35.0	31.2	44.9	51.0	63.2	72.2	75.2	70.8	68.8	55.0	38.6	33.0	53.2
1895..	26.0	32.0	37.8	52.0	62.2	72.2	70.3	74.0	70.0	48.8	42.8	33.9	51.0
Means	30.8	32.2	38.0	50.3	60.9	70.1	73.1	71.1	64.2	52.3	41.4	33.5	51.5
Range	18.3	18.0	16.4	12.6	13.1	9.8	11.0	7.2	11.8	14.4	9.7	17.2	5.5

NOTE.—Observations prior to July, 1871, were made at 8 A. M. daily, and reduced to true mean. After that date observations were made at 7 A. M., 2 P. M., and 9 P. M.

TABLE II.—TEMPERATURE DATA—ALLEGANY COUNTY.

Station.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Annual.	No. of years.	Average daily range.	Average monthly range.	Absolute maximum.	Absolute minimum.	Absolute range.
Cumberland (a)	30.8 32.2 38.0 50.3 60.9 70.1 73.1 71.1 64.2 52.3 41.4 33.5 51.5	37	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Cumberland (b)	34.4 35.2 43.0 55.1 65.1 73.8 76.1 74.0 67.8 54.7 44.8 38.0 55.2	10	..	..	..	..	..	..	..	..	..	..	..	..	..	..	103	— 12	115
Bootherville	28.7 30.4 40.2 50.6 62.3 71.3 73.6 71.4 65.0 51.7 41.0 35.0 51.8	8	..	..	..	..	..	..	..	..	..	..	..	..	..	58	109	— 19	128
Westernport	28.4 28.0 38.4 51.6 62.7 71.0 74.6 72.0 67.0 51.0 41.4 32.1 51.5	5	..	..	..	..	..	..	..	..	..	..	..	..	..	58	107	— 13	120
Flintstone	30.3 32.9 40.3 52.3 62.3 67.1 71.0 69.7 63.5 50.9 47.4 33.4 52.0	2	..	..	..	..	..	..	..	..	..	..	..	..	..	60	98	— 12	110
Frostburg *	30.8 25.8 37.9 53.4 62.0 69.5 72.0 72.2 64.0 51.5 37.6 31.7 50.7	1	..	..	..	..	..	..	..	..	..	..	..	..	..	56	94	— 22	116
Mt. Savage	30.6 26.3 40.2 51.9 61.6 64.2 69.5 70.7 65.4 51.7 44.3 32.9 50.8	1	..	..	..	..	..	..	..	..	..	..	..	..	..	..	94	..	..
Cumberland (a)																			
Cumberland (b)																			
Bootherville																			
Westernport																			
	30.6 31.7 39.9 51.9 62.8 71.6 74.4 72.2 60.0 52.4 42.2 34.6 52.5	..	..	..	..	..	..	..	..	..	..	..	..	..	..	55	109	— 19	128

* From September, 1808, to August, 1809.

The highest temperature ever officially recorded in Allegany county and also in the state of Maryland, is 109° , the maximum of

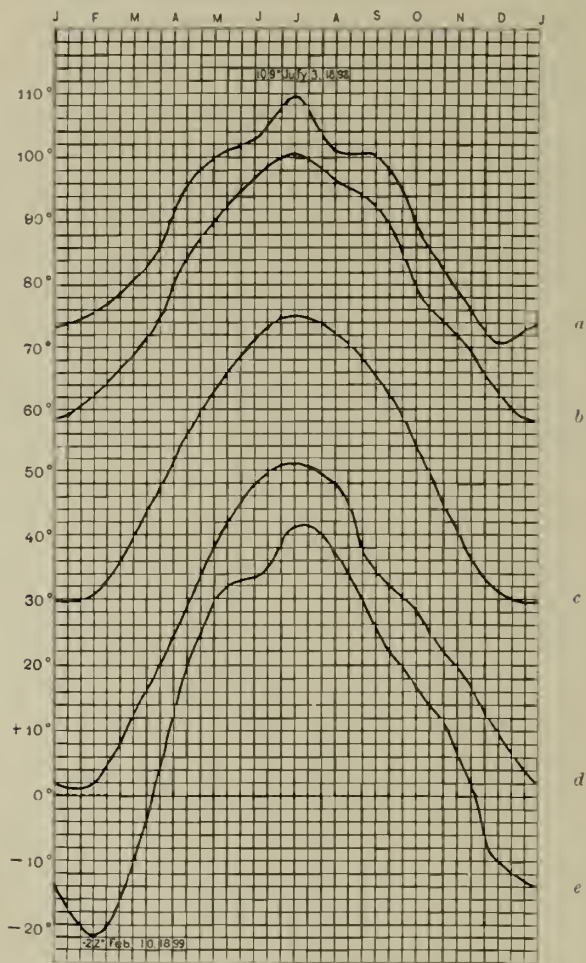


FIG. 6.

- (a) Absolute maximum temperatures in Allegany County.
- (b) Average maximum temperatures in Allegany County.
- (c) Normal temperatures in Allegany County.
- (d) Average minimum temperatures in Allegany County.
- (e) Absolute minimum temperatures in Allegany County.

July 3, 1898, reported by Mr. F. F. Brown of Boettcherville, near Cumberland. On the 13th of February of the following year a

temperature of -22° Fahrenheit was reported from Frostburg, the lowest officially recorded within the limits of Allegany county.

The occurrence of the absolute maximum and absolute minimum of temperature for Allegany county within the short period of two successive seasons is a striking coincidence, and has probably fixed the absolute range of temperature, 131° , for this county for many years to come. The records for the highest and for the lowest temperatures were broken throughout the state on these dates.

The fluctuations in temperature from year to year at Cumberland from 1859 to 1895 are graphically shown in Figure 7. From 1861 to 1871 the mean temperature was continuously below the average, while from 1872 to 1884 and from 1889 to 1894 it was above, excepting for the years 1875 and 1879.

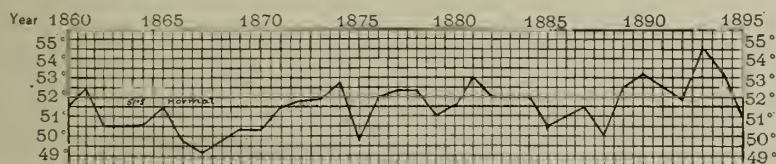


FIG. 7.—Fluctuations in mean annual temperature at Cumberland.

RAINFALL.

The rainfall record for Allegany county begins with August, 1871, and extends to the present time without interruption. The record from 1871 to December, 1895, is that of Mr. E. T. Shriver.

In 1840 Mr. T. L. Patterson kept a record of the rainfall at Cumberland for nearly one year, in connection with the construction of the Chesapeake and Ohio Canal.

In Table III we have the results of the long series of observations for Cumberland extending over a period of twenty-seven years. The maximum and minimum amounts of rainfall for each month and for the year are in *italics*, to show more clearly the fluctuations. The variations are graphically shown in the diagrams of Figures 8 and 9.

At the valley stations, Cumberland, Boettcherville, Westernport,

and Flintstone the annual rainfall is approximately 34 inches. We have at present but little more than one year's observations of rainfall at the high-level station at Frostburg. From September, 1898, to August, 1899, the rainfall measured 47.66 inches at this place. During the same period the fall at Cumberland was about 38.74

TABLE III.—RAINFALL AT CUMBERLAND, 1871-1895.

RECORD OF E. T. SHRIVER.

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
1871.....	..	..	..	..	..	..	..	3.20	2.40	6.30	2.25	0.70	..
1872.....	0.55	0.70	0.50	1.20	2.80	2.60	2.70	3.00	2.90	4.30	1.30	2.10	21.65
1873.....	2.50	2.70	2.90	2.30	4.20	4.40	4.90	3.80	0.40	2.00	1.30	1.10	32.50
1874.....	2.40	2.40	1.80	6.50	1.50	1.70	4.00	2.80	2.10	0.80	1.80	1.10	28.90
1875.....	1.00	1.20	2.20	1.20	0.30	2.90	4.60	6.10	2.50	1.30	3.80	2.40	29.50
1876.....	1.40	1.50	4.00	1.30	1.60	3.30	4.60	0.90	8.20	0.60	1.90	1.30	30.60
1877.....	0.80	0.60	3.30	2.20	1.90	2.90	4.60	1.30	2.20	3.70	5.10	0.80	29.40
1878.....	3.90	1.50	2.60	2.10	1.70	3.90	2.70	1.70	1.30	3.30	2.30	2.70	29.70
1879.....	1.00	1.30	1.40	0.60	1.10	1.90	4.10	4.60	1.00	2.00	2.10	3.40	22.50
1880.....	2.16	2.76	4.17	2.44	2.34	5.84	2.35	1.62	2.30	2.13	2.43	3.45	33.99
1881.....	1.98	3.47	1.74	1.72	1.29	5.22	3.82	0.31	2.09	2.05	1.33	4.50	29.52
1882.....	3.65	4.93	4.50	4.53	3.80	2.08	2.05	8.09	8.50	1.31	1.44	1.10	45.98
1883.....	1.80	2.80	2.20	2.57	4.73	5.38	4.05	1.46	2.59	2.09	0.87	1.75	32.29
1884.....	1.85	3.64	5.14	1.96	5.33	3.33	4.61	1.49	0.93	1.98	0.92	4.25	35.43
1885.....	3.80	2.52	1.30	1.79	2.58	0.86	1.01	3.87	0.75	4.14	1.73	1.55	25.90
1886.....	2.90	1.83	3.53	2.18	3.62	4.02	2.87	3.25	1.38	0.50	4.15	1.77	32.00
1887.....	0.30	4.38	1.57	2.61	5.64	3.87	5.59	1.12	3.68	0.39	0.82	3.00	32.97
1888.....	3.85	2.15	3.25	2.56	3.47	3.76	4.34	8.00	2.95	2.60	2.60	1.53	41.06
1889.....	3.01	2.07	3.52	3.22	7.02	3.10	2.74	1.52	4.16	2.84	5.34	1.63	40.17
1890.....	1.46	4.24	5.18	3.58	7.13	3.07	1.67	7.07	6.77	6.65	1.83	3.77	52.42
1891.....	2.93	3.99	7.47	2.02	2.57	7.69	5.17	3.44	2.46	2.21	2.92	3.42	46.29
1892.....	3.18	2.72	2.62	3.21	3.31	10.08	1.15	1.90	2.36	0.24	3.16	1.73	34.66
1893.....	0.72	3.58	1.00	3.96	4.37	2.12	1.40	3.74	1.97	4.37	2.01	0.80	30.04
1894.....	1.22	3.76	1.33	2.41	6.13	1.64	3.23	1.15	1.74	2.25	0.63	2.63	28.12
1895.....	3.53	0.98	2.45	1.63	1.52	4.42	2.49	1.81	0.15	1.20	0.34	2.51	23.03
Means ...	2.16	2.57	2.90	2.49	3.33	3.75	3.36	3.09	2.71	2.45	2.17	2.20	32.86

inches, which is 5.29 inches above the normal for Cumberland. Allowing a similar excess for this year at Frostburg we have 42.37 inches as an approximate normal rainfall for Frostburg, or between 8 and 9 inches more than at the valley stations. The monthly values for all stations are given in Table IV.

In Figure 8b we have a graphic representation of the distribution

TABLE IV.—AVERAGE MONTHLY AND ANNUAL RAINFALL.

Stations.	Year.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Annual.	No. of rainy days in a year.
Cumberland (a)	1871-1895	2.16	2.57	2.90	2.49	3.33	3.75	3.36	3.09	2.71	2.45	2.17	2.20	33.18	.
Cumberland (b)	1889-1899	2.49	3.19	3.61	2.60	4.38	3.60	2.90	3.17	2.61	2.62	2.51	2.39	35.10	86
Bootherville	1892-1898	2.45	2.82	3.16	2.65	4.43	3.88	3.22	2.72	2.70	2.46	2.52	2.52	35.53	82
Flintstone	1896-1897	3.00	3.19	4.04	2.28	3.70	3.44	4.19	2.02	5.15	0.92	4.44	1.90	38.57	87
Frostburg	1898-1899	4.53	4.86	5.34	3.40	5.95	4.37	2.64	0.96	1.96	8.28	2.62	2.75	47.66	150
Westernport	1894-1899	2.58	2.53	3.17	2.35	3.75	2.72	4.28	3.28	2.40	2.21	2.31	1.73	33.31	100
Cumberland . . . . .	. . . . .	2.43	2.66	3.12	2.49	3.88	3.38	3.63	3.09	2.61	2.41	2.42	2.19	34.34	.
Bootherville															
Westernport															

of rainfall during the year at Cumberland, based on twenty-seven years of observations. The curve indicates a fairly well-distributed rainfall throughout the year, with a maximum during the summer months and a minimum in winter. A marked feature of the curve is the sudden deflection downward during the month of April, indicating a decrease in the rainfall. A similar diminution in the amount of precipitation is shown in the records for all the stations in Allegany county.

Figure 8c shows that there has been no period of one month without some rain at Cumberland since August, 1871, though during September, 1895, there was but 0.15 inch. In this connection a quotation from a recent letter received from Mr. T. L. Patterson of Cumber-



FIG. 8c.—Fluctuations in the mean annual rainfall at Cumberland.

land by the writer is interesting: "In 1838 there was no fall of rain here from May until early in October, excepting a smart shower on the 4th of July. It was the hottest and driest year I have ever known."

In Figure 10, representing the average number of rainy days during each month of the year, we see again a fairly equal distribution of rain throughout the year, a characteristic feature of the weather in regions traversed by cyclonic storms.

While the amount and character of the rainfall of Allegany county are affected to a considerable extent by local topography, the chief controlling factor is the position of the county with reference to the centers of passing cyclonic storms. The rainfall and storm-paths have been carefully investigated for Maryland by Mr. F. J.

Walz, the meteorologist of the Maryland State Weather Service, and the results recently published in Volume I of its reports.

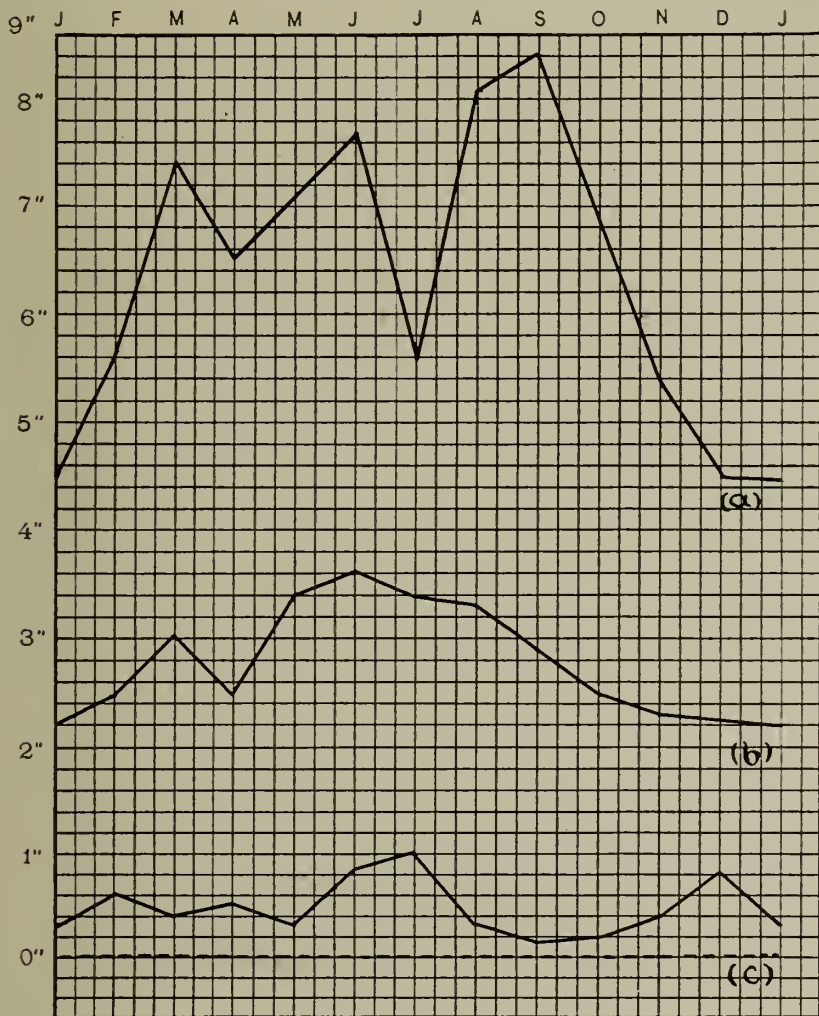


FIG. 9.—Rainfall at Cumberland (averages for 25 years).

- (a) Maximum monthly amounts.
 (b) Average " "
 (c) Minimum " "

Figure 10 shows the fluctuations in the amount of rainfall from year to year at Cumberland from 1872 to 1898, a period of twenty-

seven years. In Table IV the average monthly and annual rainfall is given for each station and also the average number of rainy days during the year.

DESCRIPTION OF STATIONS.

CUMBERLAND.—The early observations of Mr. E. T. Shriver were made at 8 A. M. daily. After 1871 he adopted the hours prescribed by the Smithsonian Institution, namely: 7 A. M., 2 P. M., and 9 P. M. The location of the station was near Washington and Allegany streets. The climatic factors recorded were temperature, rainfall, humidity, wind direction and force, cloudiness, and the general character of the weather. After the death of Mr. Shriver the observations were continued by Mr. Webster Bruce for about one year.

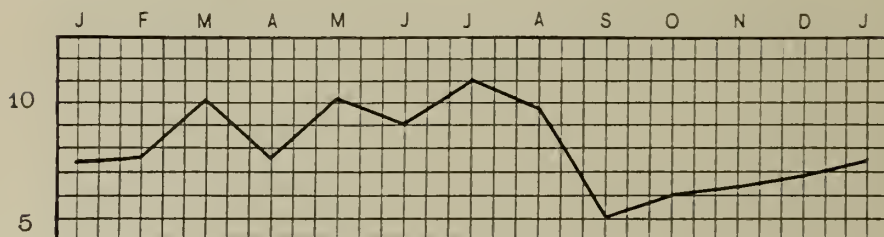


FIG. 10.—Average number of rainy days in the valleys of Allegany County.

In May of 1889 Mr. Howard Shriver began an elaborate series of observations at his residence near Fayette and Smallwood streets, and has continued them without interruption to the present time. Mr. Shriver's instrumental equipment is very complete, comprising maximum and minimum self-registering thermometers, exposed and wet-bulb thermometers, a Draper's self-recording thermometer, a barometer, and a rain-gage.

In comparing the two series of temperature observations made in Cumberland during the period of simultaneous observations from 1889 to 1896, a difference of nearly four degrees is observed in the value for the mean annual temperature. How much of this discrepancy may be accounted for by difference in hours of observation, in the character of the thermometers used, and to difference of exposure,

it is difficult to determine. The monthly mean values of Mr. Howard Shriver are uniformly from 3° to 5° higher than those of his brother. They are also higher than the readings at Boettcherville and Westernport by an equal amount. Comparing the mean daily maximum values with those at the neighboring stations at Flintstone and Westernport we find a close agreement. In the minimum readings, on the other hand, there is a wide difference, Mr. Howard Shriver's values being nearly 7° higher, as shown by the following figures:

	Cumberland.	Flintstone.	Westernport.
Mean daily maximum.....	65.1°	64.6°	63.5°
“ “ minimum.....	46.3°	39.4°	39.5°
“ “ range.....	18.8°	25.2°	24.0°

The discrepancy in the mean annual temperature must therefore be sought in the readings of the minimum thermometer.

The two series of temperature observations at Cumberland have been separately reduced to mean values in Table II.

BOETTCHERVILLE.—In 1891 Mr. Howard Shriver loaned some of his instruments to Mr. F. F. Brown in order to secure comparative observations in a neighboring locality. In November of 1891 Mr. Brown became a regular observer of the Maryland State Weather Service. From 1891 to October, 1897, temperature readings were made daily at 7 A. M. and 2 P. M. Since October, 1897, Mr. Brown has used self-registering maximum and minimum thermometers. The rainfall has been recorded regularly since November, 1891. The station is located at Boettcherville, about three miles to the west of Cumberland, in the narrow east and west valley of Braddock Run, and has an elevation of 780 feet above sea-level; it is at the base of a ridge, which rises abruptly to an elevation of about 1300 feet.

WESTERNPORT.—Observations were begun in Westernport by Professor Oliver H. Bruce in November, 1894, and have been continued without interruption to the present time. The station is equipped with a maximum and a minimum self-registering thermometer and a standard rain-gage. Westernport is built upon a slight eminence in a valley entirely shut in by mountains. The city has an elevation of about 1000 feet above sea-level.

FLINTSTONE.—The station at Flintstone was established in February of 1896 and continued in operation a little over two years. It was provided with the usual instrumental equipment of the Maryland State Weather Service, namely, a maximum and a minimum self-registering thermometer and a rain-gage. From February to May, 1896, observations were made by Mr. Newton T. Downs, from June, 1896, to April 1, 1898, by Mr. Justin Barkman. The town of Flintstone is closely hemmed in by mountains, the valley at this point being not over half a mile wide.

FROSTBURG.—The station at Frostburg was established but little over a year ago by Mr. G. G. Townsend. Observations were begun on June 1, 1898, and were continued, with the assistance of Mrs. Townsend, to the present time. Frostburg has an elevation of about 2100 feet above sea-level, and is the only active high-level station within the limits of Allegany county. The observations consist of daily readings of the maximum and minimum thermometers and a rain-gage. In addition the direction of the wind and state of the weather are recorded.

The situation of Frostburg, upon the divide between Jennings Run and Georges Creek, permits a free movement of the atmosphere from any direction. We have at the present time a little more than one year of observations. While this record is not sufficient to determine definitely the character of the climate, there is sufficient evidence to show that conditions are distinctly different from those of the lower stations.

MOUNT SAVAGE.—We have one complete year's record of the temperature at Mount Savage, made by Mr. T. C. Atkinson in 1846. Mr. Atkinson reported to the Smithsonian Institution the daily readings of the thermometer at 7 A. M., 2 P. M., and 9 P. M. Observations were made at the Eyrie House.

OLDTOWN.—The record at Oldtown covers but a fraction of one year, from May to August, 1895, and consists of readings of the maximum and minimum thermometers and the rain-gage by Dr. H. C. Shipley.

TABLE V.—METEOROLOGICAL STATIONS IN ALLEGANY COUNTY.

Station.	Observer.	Period.		Latitude.	Longitude.	Elevation, in feet.	Instruments, and Time of Observation.
		From	To				
Bootherville ...	Francis Frederick Brown ...	1891	Present.	39° 39'	78° 48'	780	Thermometer at 7a. and 2p., 1891-97. Max. and min. therm., since 1897. Rain-gage, since 1891.
Cumberland (a). {	Edwin Thomas Shriver Webster Bruce	1859 1896	1896 1897 }	39° 39'	78° 46'	700	Therm. at 7a. 1859-71; at 7a. 2p. and 9p., 1871-96; max. and min. therm., 1896-97. Barom., rain-gage, 1871-97.
Cumberland (b) ..	Howard Shriver	May, 1889	Present.	39° 39'	78° 46'	725	Therm. at 7a., 2p. and 9p.; max. and min. thermometers; rain-gage; Draper's self-record therm., barom.
Flintstone {	Newton T. Downs Justin Barkman	Feb., 1896 June, 1896	May, 1896 } Apr., 1897 }	39° 42'	78° 36'	800	Max. and min. therm. and rain-gage.
Frostburg	Mr. & Mrs. G. G. Townsend	June, 1898	Present.	39° 39'	78° 56'	2,100	Max. and min. therm. and rain-gage.
Mt. Savage (Eyrle House)	T. C. Atkinson.....	Jan., 1846	Dec., 1846	39° 42'	78° 52'	1,500	Therm. at 7a., 2p. and 9p.
Oldtown.....	Dr. H. C. Shipley	May, 1895	Aug., 1895	39° 32'	78° 37'	700	Max. and min. therm. and rain-gage.
Westernport	Prof. Oliver H. Bruce	Nov., 1894	Present.	39° 28'	79° 02'	1,000	Max. and min. therm. and rain-gage.



FIG. 1.—CAR USED IN MEASURING VELOCITY OF RIVER WATER.



FIG. 2.—MEASURING VELOCITY OF RIVER WATER FROM BOAT.

THE HYDROGRAPHY OF ALLEGANY COUNTY

BY

F. H. NEWELL

Owing to the peculiar shape of Allegany county a study of its hydrography involves not merely an examination of a few small streams but the consideration of problems whose successful solution affects the prosperity of large communities situated in several states. The county, as described in other chapters, extends along the north side of the Potomac river for a distance of about 93 miles following the course of the stream, and extending back or northerly from it for a distance of from five to fifteen or twenty miles. For simplicity of description, the name Potomac is here applied, not only to the main stream formed by the junction of the North and South forks at a point about opposite the center of the county, but also to the North Fork itself which, above this point, forms the southern boundary of the area under consideration. The general course of the river is easterly, crossing the trend of the ranges which make up the mountain system, and the Potomac thus receives from the north a considerable number of small streams draining the narrow valleys. Taking these in order down the stream, that is, from west to east, the first is Georges Creek, the only stream of importance whose drainage area is almost entirely included within the county; following this are Wills Creek, Evitts Creek, Big Spring Run, Town Creek, 15-mile Creek, and, finally, Sideling Creek, forming the eastern boundary of the county. Most of these streams rise in Bedford county, Pennsylvania, and flow in a general southerly direction across the narrow strip of Maryland constituting Allegany county.

The Potomac and the smaller tributaries flowing along or within the boundaries of Allegany county receive the run-off from precipitation which has fallen upon relatively steep and undulating surfaces covered for the most part with woodland or scattered growth of trees. The valuable timber of the original forest has long since been cut away, leaving the unmerchantable wood or second growth. The valleys and rounded hills have been partly cleared and brought under cultivation; there are no ponds or marshes such as occur in the northern glaciated regions of the United States, and thus there is little to retain the water in its course from the hillsides to the various creeks. The run-off is rapid and the amount of water percolating into the soil to reappear as springs and to feed the summer flow is relatively small. In times of deficient rainfall the streams shrink rapidly to mere rivulets, and this diminution in discharge has prevented the utilization of the flowing water in the production of power.

The principal industrial uses of the streams and springs of the region are in town or municipal supply and in manufacturing operations. There is, however, a large problem inseparably connected with the study of water resources which may be considered as bearing on the negative side, that is to say, whose proper solution may result in preventing injury to these resources rather than promoting them; this is the great question of stream-pollution—one which is not only of interest to the people of the county, but to all persons resident along the streams flowing from this area.

The matter of stream-pollution within or near Allegany county has already become one of public interest and has even reached the acute stage of contention in the courts; it is therefore not desirable to discuss the matter in a way which might be considered as reflecting upon one side or another, but to give merely some of the principal physical facts noted by a reconnaissance of the area. These will be given in connection with statements regarding the quantity of water found by the measurements made at various times.

The only systematic series of observations of flow of water within or near Allegany county has been that made at Cumberland, the results of which have been given from time to time in the reports

of the Division of Hydrography of the United States Geological Survey. Observations of river height were begun on June 11, 1894, at the West Virginia Central Railroad bridge about 200 yards below the dam on the Potomac. The gage was a vertical rod 10 feet long, bolted to the east end of the abutment of the head-gates above the dam. The channel consists of loose rocks and did not change notably. The discharge measurements were made from the bridge.¹ Measurements were made not only of the discharge of the river but also of the amount of water taken out above the dam by the feeder of the Chesapeake and Ohio Canal. On June 5, 1895, when there were 216 cubic feet per second, or second-feet, in the river, there were in the canal feeder 40 second-feet. On June 6 the river discharged 530 second-feet and the canal feeder carried 79 second-feet; on June 13 the river discharged 149 second-feet and the canal feeder carried 38 second-feet; on July 17 the river discharged 266 second-feet and the canal feeder carried 79 second-feet.² Measurements were continued through 1896, the results being shown on pages 22-24 of the Eighteenth Annual Report, Part IV, of the United States Geological Survey.³ Observations were discontinued in November, 1897.⁴

The following tables give the daily gage height as observed during the years 1895, 1896 and 1897:

The heights of water noted above show from day to day the elevation of the surface of the stream as noted upon an arbitrary gage. In order to interpret these into quantity of flow it has been necessary

¹ Report of Progress of the Division of Hydrography for the calendar year 1893 and 1894, Bulletin of the U. S. Geological Survey, No. 131, Washington, 1895, p. 88.

² Report of Progress of the Division of Hydrography for the calendar year 1895, Bulletin of the U. S. Geological Survey, No. 140, Washington, 1896, p. 46.

³ For daily gage heights, 1896, see Water-Supply and Irrigation Paper No. 11, of the U. S. Geological Survey, Washington, 1897, p. 8.

⁴ Water-Supply and Irrigation Paper No. 15, of the U. S. Geological Survey, Washington, 1898, p. 15; Report of Progress of Stream Measurements for the Calendar Year 1898, extract from the Nineteenth Annual Report, Part IV, Washington, 1899, p. 146.

to make a number of measurements of the amount of water passing the given point. For this purpose the locality has been visited at various dates given below, the width of the stream ascertained, and also its depth at short intervals across from one side to the other. At the same time the speed with which different parts of the current

DAILY GAGE HEIGHT OF POTOMAC RIVER AT CUMBERLAND, MD.,
FOR 1895.

Day	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Dec.
1.....	3.00	3.60	6.00	3.90	3.40	3.00	3.10	2.80	1.00	....
2.....	3.00	3.60	5.70	3.80	3.80	3.00	3.40	2.70	1.00	....
3.....	3.00	3.50	4.90	4.40	3.80	3.00	3.30	2.70	1.00	....
4.....	3.00	3.50	4.60	3.90	3.60	2.90	3.10	2.70	1.90	....
5.....	3.00	3.50	4.20	3.80	3.60	2.90	3.10	2.70	1.90	....
6.....	3.10	3.50	4.00	3.70	3.40	3.00	3.20	2.60	1.90	....
7.....	4.80	3.50	3.80	3.60	3.30	3.00	3.20	2.60	1.80	....
8.....	6.00	3.50	3.80	3.80	3.20	3.00	3.20	2.60	0.80	....
9.....	4.80	3.50	4.20	5.60	3.40	2.90	3.30	2.50	0.70	....
10.....	4.70	3.50	4.00	5.50	3.20	2.90	3.70	2.50	0.50	....
11.....	4.10	3.50	4.00	4.70	3.20	2.90	3.40	2.40	0.50	....
12.....	3.80	3.40	3.80	4.70	3.70	2.80	3.20	2.40	0.60	....
13.....	3.50	3.40	3.80	3.90	3.70	2.80	3.20	2.40	1.10	....
14.....	3.50	3.40	4.50	3.80	3.70	3.30	3.30	2.30	1.20	....
15.....	3.50	3.40	4.80	3.80	3.50	3.30	3.30	2.20	1.00	....
16.....	3.90	3.30	5.20	3.80	3.30	3.20	3.30	2.10	0.90	....
17.....	3.90	3.40	4.70	3.80	3.40	3.20	3.00	2.00	0.90	....
18.....	3.90	3.40	4.50	3.70	3.40	3.10	3.00	1.90	0.80	....
19.....	3.80	3.40	4.30	3.60	3.40	3.00	2.90	1.80	0.70	....
20.....	3.80	3.40	4.10	3.50	3.30	3.00	2.90	1.70	0.50	....
21.....	3.90	3.40	3.80	3.40	3.40	2.90	2.70	1.60	0.40	....
22.....	4.60	3.40	3.70	3.40	3.40	3.00	2.70	1.30	0.50	3.00
23.....	4.00	3.40	3.70	3.30	3.40	3.00	2.70	1.20	0.20	3.20
24.....	3.70	3.40	3.70	3.30	3.40	3.00	2.70	1.10	0.10	2.90
25.....	3.60	3.40	3.70	3.20	3.30	2.90	2.70	1.00	(a)	2.90
26.....	3.50	3.60	4.50	3.30	3.20	3.00	2.70	0.90	....	3.00
27.....	3.50	4.10	4.30	3.30	3.30	3.00	2.70	0.90	....	2.90
28.....	3.40	5.00	4.30	3.30	3.20	3.30	2.80	0.90	....	2.90
29.....	3.40	....	5.10	3.30	3.10	3.20	2.90	0.90	....	2.90
30.....	3.70	....	4.50	3.40	3.10	3.00	2.90	0.80	....	3.10
31.....	3.70	....	4.50	....	3.10	....	2.80	0.90	....	3.00

(a) Water 5 inches below gage. Readings discontinued till December 22.

is moved has been ascertained by means of suitable devices known as current meters. These usually consist of small wheels or turbine screws so constructed that the flowing water causes them to revolve. The rate of revolution of the wheel is dependent upon the speed of the water. Each revolution is made known or recorded by suitable



PRICE ELECTRIC CURRENT METERS, WITH BUZZERS.

electrical device, and when the relation between the revolution of the wheel of the current meter and the velocity of the stream has once been ascertained it is a relatively simple mechanical matter to compute the rate of flow at any point across or beneath the surface of a river. The following table gives in cubic feet per second, or second-

DAILY GAGE HEIGHT OF POTOMAC RIVER AT CUMBERLAND, MD.,
FOR 1896.

Day	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1.....	2.90	4.60	3.90	5.00	4.50	3.60	3.10	3.80	2.60	5.50	3.10	3.70
2.....	2.90	4.80	3.70	4.80	4.50	3.50	3.10	3.80	2.70	4.50	3.10	3.50
3.....	3.00	4.00	3.00	4.40	4.50	3.40	3.10	3.80	2.70	4.50	3.10	3.40
4.....	2.90	3.80	3.30	4.20	4.50	3.50	3.10	3.70	2.70	3.50	3.20	3.30
5.....	2.90	3.80	3.10	3.80	3.40	3.30	3.10	3.30	2.70	3.40	3.20	3.30
6.....	2.90	3.80	3.10	3.80	3.30	3.30	2.90	3.30	2.80	3.30	5.50	3.30
7.....	2.90	4.50	3.10	3.70	3.10	3.80	2.90	3.20	2.90	3.10	4.50	3.30
8.....	2.90	3.90	3.60	3.70	3.00	3.70	2.90	3.20	2.90	3.10	3.80	3.20
9.....	2.90	3.00	3.40	3.70	3.00	3.40	3.10	3.40	2.90	3.10	3.80	3.30
10.....	2.90	3.40	3.30	3.70	3.00	3.40	3.70	3.40	2.90	3.00	3.70	3.30
11.....	2.90	3.10	3.30	3.70	2.90	3.40	3.40	3.30	2.80	3.00	3.60	3.40
12.....	3.00	3.30	3.40	4.30	2.90	3.40	3.30	3.30	2.70	3.10	3.50	3.60
13.....	3.00	4.90	3.10	4.30	3.50	3.20	3.10	3.10	2.90	3.10	3.50	3.40
14.....	3.00	4.10	3.10	4.10	3.50	3.20	3.00	3.60	3.00	3.00	3.40	3.30
15.....	3.00	3.80	3.10	3.90	3.30	3.30	3.00	3.50	3.10	3.00	3.20	3.30
16.....	3.00	3.80	3.20	3.80	3.20	3.30	3.00	3.30	3.50	3.00	3.10	3.30
17.....	3.00	3.50	3.30	3.80	3.10	3.70	3.00	3.10	3.00	3.00	3.10	3.30
18.....	3.00	3.50	3.30	3.70	3.40	4.10	3.50	3.00	3.00	3.00	3.20	3.30
19.....	2.90	3.20	3.50	3.50	3.50	3.70	3.10	2.90	3.00	2.90	3.30	3.30
20.....	2.90	3.20	3.60	3.50	3.80	3.60	3.10	2.90	2.90	2.90	3.30	3.30
21.....	3.00	3.20	3.70	3.50	3.80	3.30	3.30	3.00	3.00	3.10	3.20	3.20
22.....	3.00	3.20	3.70	3.50	3.60	3.30	4.00	3.00	3.10	3.10	3.30	3.20
23.....	3.00	3.30	4.00	3.30	3.40	3.20	4.70	3.00	3.10	3.10	3.30	3.20
24.....	3.10	3.10	3.90	3.40	3.40	3.50	4.60	3.20	3.00	3.30	3.40	3.20
25.....	3.50	3.30	3.70	3.50	3.50	3.50	10.00	3.00	3.00	3.70	3.30	3.20
26.....	3.30	3.30	4.00	3.50	3.50	3.60	6.50	2.90	3.00	3.50	3.30	3.20
27.....	3.10	3.30	5.00	3.50	4.00	3.50	4.70	2.90	3.00	3.20	3.20	3.10
28.....	3.00	3.20	4.50	3.50	3.70	3.30	4.90	2.90	2.90	3.20	3.20	3.10
29.....	3.00	3.70	5.80	3.50	4.10	3.30	4.50	2.90	2.90	3.10	3.90	3.10
30.....	3.70	....	8.00	3.40	4.00	3.20	4.50	2.90	10.00	3.10	4.00	3.10
31.....	4.20	....	6.00	....	3.80	....	4.50	....	....	3.10	....	3.20

feet, the results of these measurements made at various times since 1894. It also shows the height of water, the area of the section in square feet, and the average or mean velocity of the entire stream at that time and place.

From the observations of height of water and the measurements of discharge made at various times, rating tables have been made

giving approximately the amount of water flowing in the stream corresponding to different heights on the gage. This has been constructed by plotting upon cross-section paper the height of water and the discharge by the relative distance from one side of the drawing; in other words, by plotting these points according to rectangular

DAILY GAGE HEIGHT OF POTOMAC RIVER AT CUMBERLAND, MD.,
FOR 1897.

Day	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1.....	3.20	3.40	4.00	3.50	3.50	2.90	2.70	3.00	2.60	2.20	2.80	....
2.....	3.20	3.50	3.80	3.40	7.50	2.80	2.70	3.00	2.50	2.00	3.00	....
3.....	3.30	3.60	3.90	3.40	5.50	2.80	2.70	2.90	2.50	1.90	3.00	....
4.....	3.30	3.40	5.20	3.70	5.00	2.80	2.70	2.90	2.50	1.70	3.10	....
5.....	4.00	3.40	4.90	3.80	4.60	2.80	2.70	3.50	2.40	1.70	3.00	....
6.....	4.00	3.50	6.00	3.70	4.10	2.80	2.60	3.20	2.40	1.60	2.90	....
7.....	3.70	4.50	5.00	3.60	4.10	2.80	2.60	3.10	2.20	1.50	2.90	....
8.....	3.40	4.20	4.40	5.20	3.90	2.80	2.70	3.20	1.90	1.40	3.00	....
9.....	3.30	4.00	4.60	5.40	3.70	2.90	2.70	3.10	1.80	1.40	4.00	....
10.....	3.40	3.70	4.20	4.50	3.70	2.70	2.70	3.00	1.80	1.50	3.40	....
11.....	3.20	3.60	4.00	4.50	3.60	2.70	2.80	3.00	1.70	1.30	3.40	....
12.....	3.20	3.50	4.00	4.10	4.00	2.70	2.90	2.90	1.60	1.30	3.30	....
13.....	3.20	3.70	3.90	4.00	4.40	2.60	2.90	2.90	1.50	1.30	3.20	....
14.....	3.20	4.00	3.80	3.80	5.40	2.50	2.80	2.80	1.40	1.40	3.20	....
15.....	3.20	4.20	4.00	3.90	4.60	2.50	2.80	3.00	1.30	1.50	3.50	....
16.....	3.20	4.70	3.80	3.90	4.30	3.00	2.80	3.00	1.20	1.50	3.50	....
17.....	3.40	4.50	3.70	3.70	3.90	3.00	2.70	2.90	1.20	1.40	3.40	....
18.....	3.70	5.00	4.00	3.70	3.80	2.90	2.80	2.80	3.20	1.40	3.30	....
19.....	3.50	4.80	4.50	3.60	3.70	2.90	2.80	2.90	3.00	1.40	3.30	....
20.....	3.40	3.50	4.80	3.70	3.50	2.90	2.90	2.90	2.90	1.40	3.20	....
21.....	3.40	3.50	4.60	3.50	3.30	3.00	3.20	2.90	2.80	1.40	....	....
22.....	3.50	10.50	4.20	3.30	3.30	3.00	3.00	2.90	2.70	1.30	....	....
23.....	3.40	8.70	4.00	3.30	3.30	2.90	3.00	2.90	2.60	1.30	....	....
24.....	3.40	6.20	4.20	3.30	3.00	2.90	3.00	2.90	2.80	1.50	....	....
25.....	3.30	5.10	4.10	3.20	3.00	3.00	3.00	2.90	3.00	1.60	....	....
26.....	3.30	4.50	4.00	3.10	3.00	2.90	2.90	3.00	3.00	1.60	....	....
27.....	3.30	4.30	3.90	3.00	3.00	2.90	3.20	3.00	2.90	1.70	....	....
28.....	3.30	4.00	3.80	3.00	3.00	2.90	3.10	3.00	2.80	1.70	....	....
29.....	3.30	....	3.70	3.00	2.90	2.90	3.10	2.90	2.80	2.40	....	....
30.....	3.30	....	3.60	2.90	2.90	2.80	3.10	2.80	2.70	2.70	....	....
31.....	3.30	....	3.60	....	2.90	....	3.00	2.60	....	2.70	....	....

co-ordinates. Through the series of points thus obtained a smooth curve has been drawn averaging the conditions and giving for each tenth of a foot height on the gage a corresponding flow of discharge. These rating tables are given below in condensed form.

By applying the values given in the above tables, a statement has been prepared of the average daily flow throughout the period. From

LIST OF DISCHARGE MEASUREMENTS MADE ON POTOMAC RIVER AT CUMBERLAND, MD.¹

No.	Date.	Hydrographer.	Meter number.	Gage height (feet).	Area of section (square feet).	Mean velocity (feet per second).	Discharge (second-feet).
1	1894. May 24	C. C. Babb	23	....	1,166	2.60	3,037
2	1895. Mar. 30	....do	29 l	4.50	1,088	3.17	3,446
3	Apr. 10	....do	29 l	5.40	1,560	3.88	6,054
4	Apr. 25	....do	29 h	3.30	423	1.49	630
5	May 3	....do	29 h	3.75	722	2.39	1,728
6	May 9	....do	29 h	3.40	465	1.67	777
7	May 23	....do	29 h	3.40	569	1.46	831
8	June 5	....do	29 h	2.95	373	0.69	256
9	June 6	....do	29 h	3.10	445	1.37	609
10	June 13	....do	29 h	3.00	334	0.86	287
11	July 17 1896.	....do	76	3.05	357	0.97	345
12	June 24	D. C. Humphreys..	W. B.	3.31	580	1.42	822
13	Aug. 6	....do	W. B.	3.30	355	1.71	605
14	Nov. 18	A. P. Davis	68	3.38	577	1.33	765
15	Feb. 10	....do .....	....	3.75	....	....	1,307
16	Mar. 27	....do .....	....	3.93	....	....	1,995
17	June 25	....do .....	....	3.00	....	....	425
18	Sept. 1	....do .....	....	2.60	....	....	86
19	Sept. 22	....do .....	....	2.70	....	....	92

¹ Gagings include discharge of canal feeders.RATING TABLES FOR POTOMAC RIVER AT CUMBERLAND, MD.,
1895, 1896 AND 1897.

Gage Height in feet.	Discharge in second-feet.			Gage Height in feet.	Discharge in second-feet.		
	1895.	1896.	1897.		1895.	1896.	1897.
2.7	160	160	110	4.3	3,070	3,070	3,015
2.8	200	200	140	4.4	3,325	3,325	3,295
2.9	250	240	180	4.5	3,580	3,580	3,575
3.0	325	300	255	4.6	3,835	3,835	3,855
3.1	425	400	375	4.7	4,090	4,090	4,135
3.2	525	500	525	4.8	4,345	4,345	4,415
3.3	650	650	680	4.9	4,600	4,600	4,695
3.4	800	800	835	5.0	4,855	4,855	4,975
3.5	1,030	1,000	990	5.2	5,365	5,365	5,535
3.6	1,285	1,285	1,165	5.5	6,130	6,130	6,375
3.7	1,540	1,540	1,365	6.0	7,405	7,405	7,775
3.8	1,795	1,795	1,615	7.0	....	....	10,575
3.9	2,050	2,050	1,895	8.0	....	....	13,375
4.0	2,305	2,305	2,175	9.0	....	....	16,175
4.1	2,560	2,560	2,455	10.0	....	....	18,975
4.2	2,815	2,815	2,735	11.0	....	....	21,775

these averages a condensed table giving the greatest and least flow for each month and the average for that month in second-feet has been compiled for convenience of reference. The average flow for the month is also given in another form in comparison with the area

ESTIMATED MONTHLY DISCHARGE OF POTOMAC RIVER AT
CUMBERLAND, MD.

[DRAINAGE AREA, 891 SQUARE MILES.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Depth in inches.	Second-feet per square mile.
1895.					
January	7,405	325	1,844	2.39	2.07
February	4,855	650	1,128	1.32	1.27
March	7,405	1,540	3,185	4.12	3.57
April	6,385	525	1,875	2.35	1.10
May	1,795	425	870	1.13	0.98
June	650	200	335	0.45	0.40
July	1,540	160	431	0.55	0.48
1896.					
January	2,815	240	438	0.56	0.49
February	4,600	400	1,498	1.81	1.68
March	12,505	300	1,991	2.57	2.23
April	4,855	650	1,792	2.24	2.01
May	3,580	240	1,351	1.75	1.52
June	2,560	500	1,396	1.75	1.57
July	17,600	300	2,141	2.77	2.40
August	1,795	200	656	0.85	0.74
September	17,600	140	859	1.07	0.96
October	6,130	240	868	1.12	0.97
November	6,130	400	1,116	1.39	1.25
December	1,540	400	654	0.84	0.73
Per annum	17,600	140	1,230	18.72	1.38
1897.					
January	2,175	525	836	1.08	0.94
February	20,375	835	3,610	4.21	4.05
March	7,775	1,165	2,744	3.55	3.08
April	6,095	180	1,570	1.96	1.76
May	11,975	180	2,162	2.79	2.42
June	255	80	165	0.21	0.19
July	525	85	199	0.25	0.22
August	990	85	256	0.33	0.29
September (a)	525	10	70	0.09	0.08
October (a)	110	20	40	0.04	0.04

(a) Approximate.

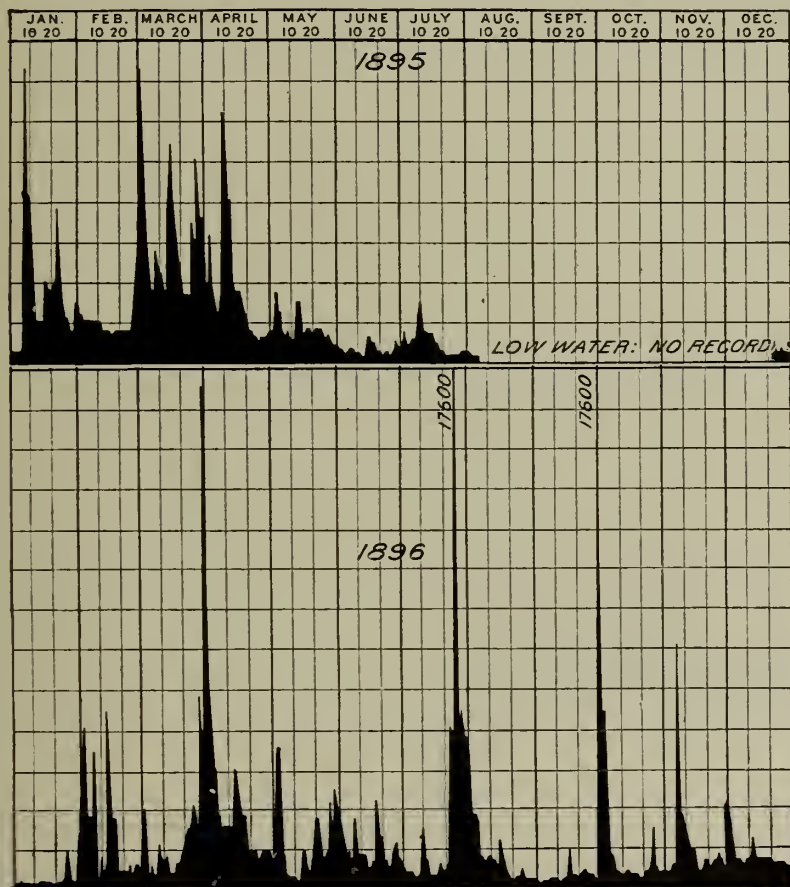


FIG. 1.—GEORGES CREEK AT WESTERNPORT, NEAR THE
CONFLUENCE WITH NORTH BRANCH OF POTOMAC.



FIG. 2.—GEORGES CREEK AT WESTERNPORT, LOOKING
UP-STREAM FROM WASHINGTON STREET BRIDGE.

drained. That is to say, above the point of measurement there are 891 square miles; if it is assumed that the water comes equally from all parts of this surface (which, however, it does not do) and that the average for the month is 1,782 second-feet, there would be an average



FIGS. 11 AND 12.—Diagram showing discharge of the North Branch of the Potomac at Cumberland for 1895 and 1896.

of 2 second-feet per square mile drained. This expression is of convenience in considering the probable amount discharged from a larger or smaller drainage area of similar character, that is to say,

from a portion of the drainage area above Cumberland, embracing say 500 square miles, it is reasonable to assume that about 1,000 cubic feet per second flowed during the month. As a matter of fact, however, the run-off from a smaller drainage area is usually relatively greater than from a large drainage area, because the smaller often includes a greater proportion of mountain or rough land at the headwaters of the streams. The table also gives the average flow per month in terms of depth in inches over the whole surface drained.

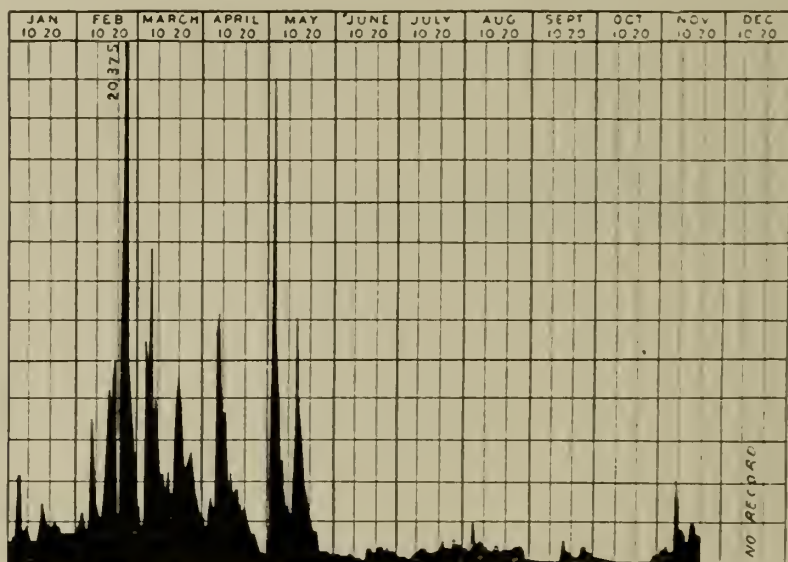


FIG. 13.—Diagram showing discharge of the North Branch of the Potomac at Cumberland for 1897.

The rainfall records give the precipitation upon the surface in depth in inches and the amount flowing from the surface has also been computed in depth in inches for convenience of comparison of the run-off with the rainfall.

In addition to the measurements of discharge at Cumberland, a number of determinations of the flow of various streams were made during the reconnaissance of the Potomac Basin before mentioned. This was carried on during the unusual drought of the fall of 1897,

the field work being by Mr. Arthur P. Davis and his assistants, Mr. E. G. Paul and Mr. Gerard H. Matthes.¹

The country was systematically examined as far as practicable and facts bearing upon the quantity of water and also upon its utilization or pollution were obtained. From time to time samples of water were taken. These were referred to the Supervising Surgeon-General of the Marine Hospital for examination, the results being published in a report² by the latter organization. The following details have been taken largely from the field-notes of the hydrographers above named.

The water of the North Branch of the Potomac, even near its head, is naturally somewhat dark in color, and it is stated by the older inhabitants of the region that it has always been thus dark, owing, probably, to the presence of decaying vegetable matter from the forests. This discoloration is further increased by the effluents from sawmills, tanneries and coal mines, so that at the old mill-dam near Keyser, where the polluted water, agitated by the falls, boils and foams, a thick layer of whitish-brown froth is formed. Within the northern part of its drainage area, including Allegany county, and particularly in the vicinity of Cumberland, are, as is well known, a considerable number of large coal mines furnishing employment to hundreds of laborers. The drainage water from these mines, as they are deepened, becomes considerable in quantity, and as this is pumped directly into the smaller streams, stains the waters of the creeks which, above point of inflow, are usually bright and clear.

The headwaters of the North Branch proper are at the Potomac Spring near the Fairfax Stone on the present West Virginia and Maryland state line at an elevation of about 3,000 feet. From this the river flows in a northeasterly direction for about 46 miles, forming the dividing line between Garrett county, Maryland, and Grant county, West Virginia, to the confluence of Savage river, where the

¹ Drainage Basin of the Potomac, Fifty-fifth Congress, second session, Sen. Doc. No. 90; also Nineteenth Annual Report, Part IV, pp. 132-161.

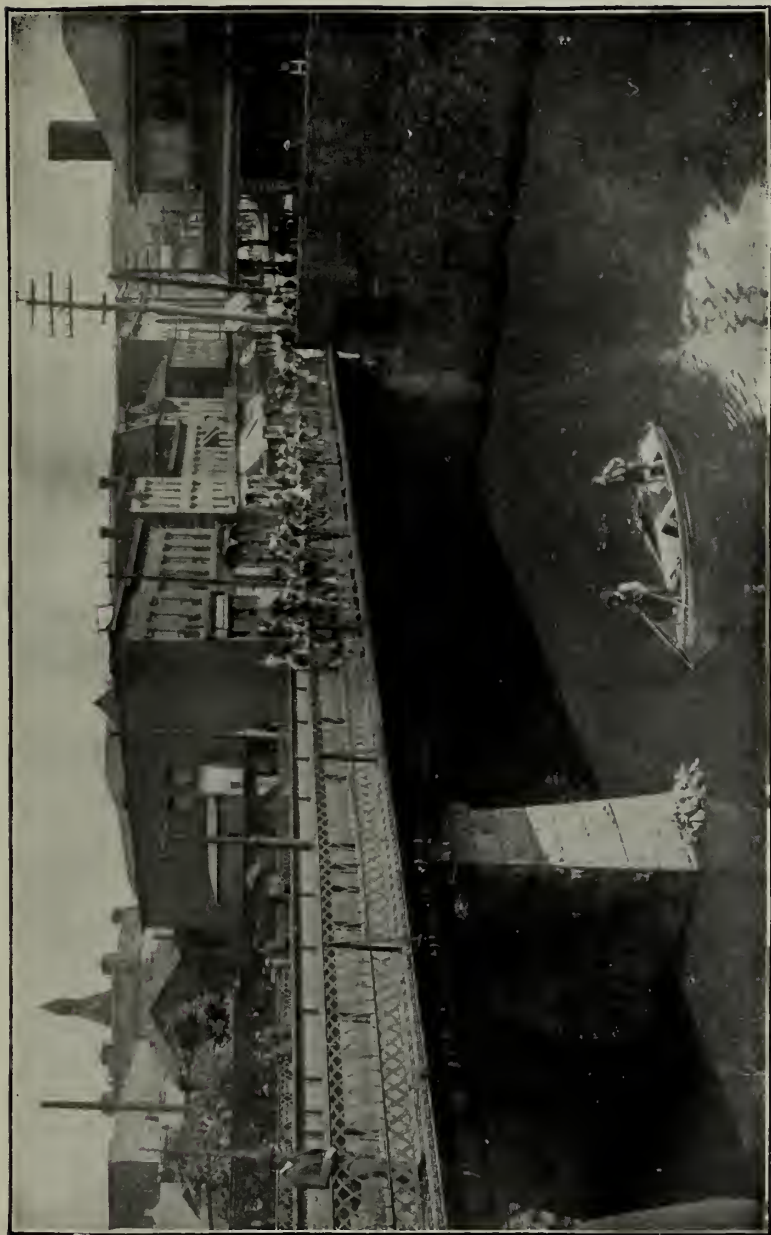
² Bacteriological Examination of the Potomac River, Senate Doc. No. 211, Fifty-fifth Congress, second session.

elevation is over 950 feet.¹ From this point on it forms the boundary of Allegany county, separating it from Mineral county, West Virginia. From the mouth of Savage river the course is southeasterly for a distance of 6 miles to Keyser, on the West Virginia side of the river. Here the stream abruptly resumes its northeasterly course and continues for 23 miles, reaching Cumberland at an elevation of 600 feet. At this point again, the river sharply turns and continues southerly for 12 miles, where it joins the South Branch to form the main Potomac.

Along the upper part of its course, down to Westernport, the most westerly town in Allegany county, the North Branch flows through a narrow, tortuous valley, the steep, wooded hillsides of which afford little opportunity for settlement. The roads are few and bad, and the West Virginia Central and Pittsburg Railway affords the only means of transportation. The extensive lumber trade in this region is responsible for a number of small settlements along the river and the existence of the two towns of Bayard, West Virginia, with an estimated population of 700, and Gormanias, West Virginia, with an estimated population of 600 inhabitants.

Owing to its considerable fall along this section, which averages 46 feet per mile, but in some portions exceeds 60 feet per mile, the river assumes much the nature of a mountain torrent, presenting one continuous series of riffles and falls, the latter in some instances having a drop of 5 feet and over. There seems to be little opportunity for developing the waterpowers of this stream, however considerable they may be. Freshets are frequent and heavy, and would inflict serious damage to the cheaper forms of milldams. Stone and brush dams, crib dams, and loose-rock dams would either be swept away or would require incessant repairs and rebuilding. On account of the narrowness of the valley, waste-weirs would be impracticable, and dams would have to be built to withstand the heaviest floods passing over them, which would render their construction elaborate and expensive. It is only difficult to find good mill sites. The following discharge measurements, made in September and October of 1897, will serve to

¹ Nineteenth Annual Report, Part IV, U. S. Geological Survey, p. 141.



WILLS CREEK AT CUMBERLAND.

throw light upon the capacity of the river during the dry season: September 23 a measurement made at Gormanias, West Virginia, gave a discharge of 54 second-feet. On September 25 the discharge of the river at Schell was 136 second-feet. Measurements made above the junction with Savage river on September 27 and October 27 gave discharges of 122 and 102 second-feet, respectively, the latter fairly representing the capacity of the North Branch at this point during the severe drought of 1897. These results, together with the large amount of available head and the fact that the river does not freeze over in winter, seem to indicate that there would be ample power at all times for average milling purposes. The fact that no attempt has been made by any of the sawmills and tanneries along the river to make use of waterpower has, however, sufficient explanation. The first-named enterprises use steam by preference, because they are primarily of a temporary character, liable to be shifted whenever it may be found advantageous to shorten the distance which the raw materials are to be hauled, and also because they are supplied with an abundance of fuel, at no cost, in the form of sawdust. The tanneries, though of a more permanent character, invariably prefer steam power, because, besides being able to utilize tan bark as fuel, they require the use of steam in their processes.

A small waterpower has been developed by two mills at Blaine, West Virginia, but the amount is trifling in comparison with what might be obtained at that point. One 15-inch and one 18-inch turbine under $7\frac{1}{2}$ feet head furnish about 8 horsepower to a small woolen mill. On the same mill-race is situated a sawmill and grist-mill combined, which obtains about 25 horsepower from one 36-inch turbine under 9 feet head. Water is taken from the river at a point about one-half mile above the mills, where there is a low natural dam across the river.

The more important tributaries were visited and the discharges measured. September 24 the discharge of Buffalo Creek at Bayard, West Virginia, was found to be 23 second-feet. The water was heavily laden with sawdust from the Buffalo Lumber Company. Stony river, the principal tributary above the mouth of Savage river, was visited September 25. Its discharge was 38 second-feet. This

stream flows through a hilly region, covered with thick timber growths, and has no settlements along it except a few logging camps. The headwaters rise in the highest part of the Potomac Basin, at an altitude of 4,000 feet. September 25 Abram Creek showed a discharge of 7.4 second-feet. The water of this creek carries much coaldust from the mines at Elk Garden, West Virginia, and also receives sawdust from a sawmill at Emory, West Virginia.

The North Branch all along this upper section is polluted by large quantities of sawdust produced by fourteen sawmills, some of which discharge the sawdust directly into the river, and others into the tributaries. The more important of these are the sawmill of the J. L. Rumbarger Company, at Dobbin, West Virginia, with a capacity of 100,000 feet of lumber a day, the saw- and planing-mills of M. N. Wilson, at Wilson, Maryland, with a capacity of 20,000 feet of lumber a day, and of the Buffalo Lumber Company, at Bayard, West Virginia, with a capacity of 50,000 feet of lumber a day. It furthermore receives the wastes from two tanneries—those of the Middlesex Leather Company, at Bayard, West Virginia, with a capacity of from 600 to 800 hides a day, and the J. T. Hoffmann's Sons Company, at Gormanania, West Virginia, with a capacity of 300 hides a day. The wastes from the latter establishments consist of tan liquor, lime water, and a certain amount of tan bark, which is washed from the banks at times of high water. The total amount of this pollution is such that the river, especially during the dry season, has a foul appearance in spite of its dashing course over the bowlders of its rough but picturesque bed. The water has a dark-brown tinge, very suggestive of contamination by tan liquor, and particles of sawdust are extremely plentiful and are carried for long distances. In many places where irregularities in the current have caused accumulations of sawdust, small banks and bars composed of solid strata of sawdust are to be found. It is a noteworthy fact that Stony river, though free from artificial pollution, exhibits to a certain degree the same dark color peculiar to the waters of the main river.

About 2 miles above Westernport, Savage river empties into the North Branch. It is a small stream of great purity, having its

headwaters in Garrett county. Only two small sawmills are located on its banks, and the pollution caused by them is insignificant. A discharge measurement made October 27 at the mouth of the stream, above the intake of the Piedmont water supply, gave a discharge of 11.3 second-feet. The town of Piedmont and part of Westernport are supplied with drinking water by a gravity system, from a reservoir which is kept filled by pumping water from Savage river. The quantity pumped daily is estimated at 375,000 gallons.

One-half mile above Westernport, at Luke, is the factory of the Piedmont Pulp and Paper Mill Company, which has a daily capacity of 40 tons of book paper and 50 tons of pulp. In the process of manufacturing the pulp from spruce and poplar wood the wood-fiber is disintegrated by treating with bisulphite of lime, and a number of chemical residuals are formed which are discharged into the river. These chemicals consist principally of sulphates and sulphites of calcium, some free sulphuric and sulphurous acids, chloride of calcium used in bleaching the fiber, and a large amount of resinous matter. An analysis, made of a sample of the effluent from one of the digesters, shows acids as follows:

	Grams per liter.
SO ₃ (sulphuric acid and sulphates)	1.030
SO ₂ (sulphurous acid, sulpho-acids, etc.)	8.800
Total SO ₃ after complete oxidation	12.030

It further appears from the analysis that but little of the acid occurs in a free state, being chiefly combined with organic matter contained in the effluent.

Besides these chemical compounds, wastes of a more solid nature are discharged into the river at this point. A small amount of pulp is lost in the washing of the fiber; its escape is more or less accidental, signifying a loss against which the owners of the mill keep careful watch. The sediments from the filter tanks, representing the materials carried in suspension by the river water, are screened out before the water can be used in the process of manufacturing pulp and paper, and are returned into the river. The filtering plant, established solely for this purpose, was put in at a cost of \$35,000. The water of the North Branch is, therefore, hardly fit for industrial

purposes, much less for domestic use. The action of the acids on the clay contained in the water, together with the small amount of pulp referred to, forms a gray compound which is found to coat the stones in the bed of the river below the mill, and is frequently spoken of as waste pulp.

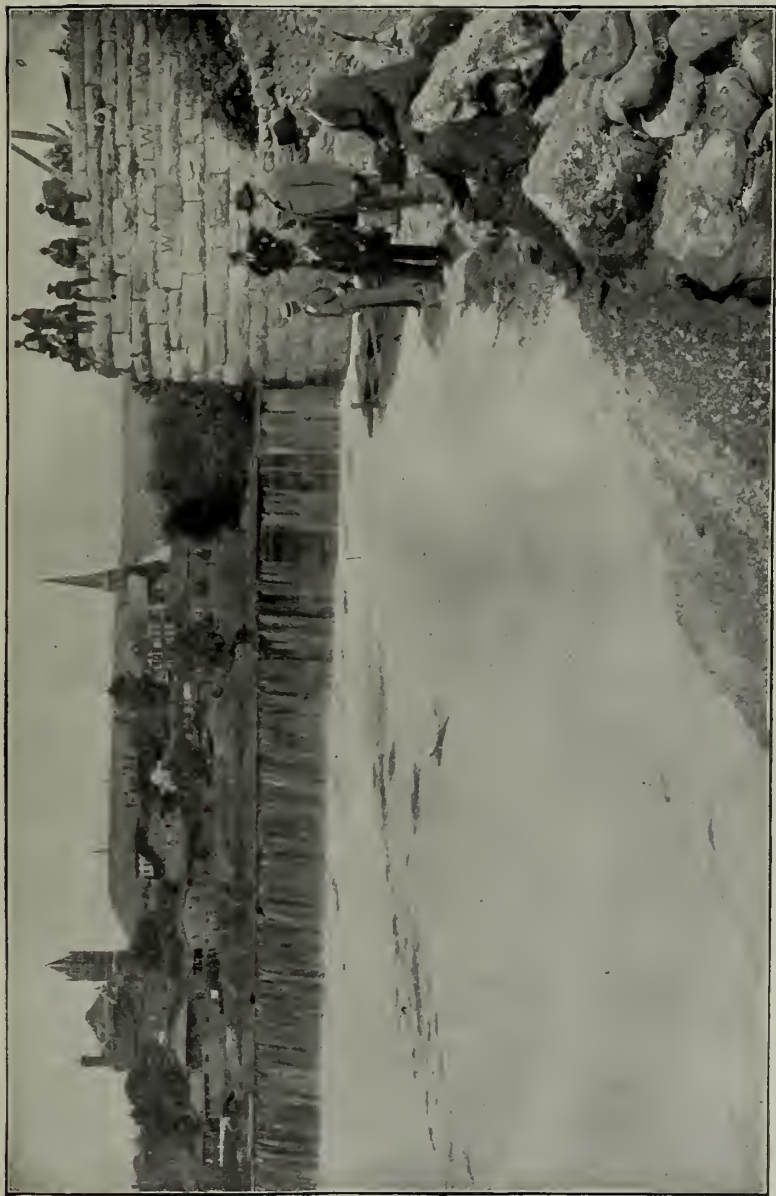
The North Branch, in passing the towns of Piedmont and Westernport, receives a large amount of impurity in the form of sewage and garbage, and is badly polluted by the water of Georges Creek, which enters the river at Westernport. This small stream, in its course of 17 miles, receives the effluents of a number of coal mines, besides the drainage and sewage of several towns, the most important of which are Frostburg, Lonaconing and Westernport, with populations of 6,000, 4,200 and 2,000 respectively.

When measured at Westernport September 28, 1897, the discharge of Georges Creek was found to be 6 second-feet, a very low stage. The water, which is very clear, possesses such acidity that horses and cattle refuse to drink it, and no living organisms can be seen in it. An analysis shows acids as follows:

	Grams per liter.
Combined sulphuric acid, as SO_3	0.7350
Free sulphuric acid, as SO_3	0.1047
Sulphurous acids and sulphites	None.

The water also contains a large quantity of alumina. The presence of the sulphuric acid and sulphates is due to the large percentage of ferric sulphate contained in the coal-mine effluent. Being an unstable compound, it breaks up when acted upon by the oxygen of the air, parting with the iron which settles on the rocks in the bed, forming a coating of ferric hydroxide which gives to the entire stream a very rusty appearance.

The North Branch, between Westernport and Keyser, West Virginia, has little fall. Near the latter town it passes over an old mill-dam. The fall, though slight, causes a thick froth to form on the water, covering the entire river below the dam with a white coat of scum several inches deep, a strong evidence of the foulness of the water. The town of Keyser, which has an estimated population of 3,500, although not situated on the banks of the North Branch, adds



DAM AT CUMBERLAND FOR DIVERTING WATER INTO THE CHESAPEAKE AND OHIO CANAL.

materially to the pollution of the latter. New Creek, a tributary of the North Branch, passes through the town and carries off, besides sewage, the effluents from the Keyser woolen-mills. The waste water resulting from the washing of the wool with sal soda and soap probably constitutes the most obnoxious element in this effluent, containing as it does much animal matter subject to decay. The pollution from this source alone is estimated at 1,200 gallons a day. Besides this, a variety of chemicals are discharged into the water, together with much coloring matter used in dyeing the wool. On New Creek 6 miles above Keyser is situated a tannery owned by the United States Leather Company with a capacity of 60 hides a day. All waste tan liquor is discharged into the creek, the waters of which are discolored for a distance of 3 miles below the tannery. There are two small sawmills on this stream, but the sawdust discharged by them is insignificant in amount. The discharge of New Creek was measured near its mouth on September 29, and found to be 3.5 second-feet. There are a number of mills and manufactories of various kinds at Keyser, all of which were visited, but none were found to contribute in any measure to the pollution of the river. At the Baltimore and Ohio car shops, at the time of visit, a sewer to drain the sewage of the shops into the North Branch was under construction. The number of hands employed aggregates 160.

Along the 23 miles of its course from Keyser down to Cumberland, the North Branch receives no pollution other than that from natural sources. A distillery on Cranberry Run and the works of the Cumberland Cement Company, both situated near Pinto post-office, were visited, but no wastes observed at these points. The river along this section has an average fall of 12 feet per mile and riffles are few in number.

At Cumberland, the North Branch assumes a totally different aspect. A tight dam maintained across the river at this point by the Chesapeake and Ohio Canal Company for diverting the water of the river into the head of the canal, impounds the water over a distance of a mile, causing back water for about 3 miles up the river. Above this dam is the mouth of Wills Creek, which flows through the city,

receiving a large quantity of sewage and refuse from a paper-mill, a brewery, a distillery, cement works, a tannery, dye works, and a gas plant. The city of Cumberland has a population of about 15,000. The mayor states that about one-half of the houses in the city are provided with sewers which drain directly or indirectly into the Potomac. A supply of 2,500,000 gallons of water is furnished daily to the people of the city, and the resulting drainage must be more than 1,000,000 gallons per day, most of which is discharged into Wills Creek. Along this stream are located a number of coal mines, the drainage of which also reaches the creek. A discharge measurement made September 28, 1897, above the paper-mill gave a discharge of 12.5 second-feet. As may be expected, the refuse thrown into Wills Creek, the polluting substances carried by the waters of the North Branch as enumerated above, and the sewage from the city of Cumberland accumulate in the pond above the dam as if in a settling basin. This is the case especially in seasons of low water, when no water passes over the crest of the dam. About 400 yards above the dam is the intake of the Cumberland waterworks; the water is pumped from the river directly into the water mains and is served to the inhabitants without being purified through filter beds or other artificial means. Serious complaints have arisen from year to year during the dry season, when the water, besides being unpalatable, is scarcely clean enough for laundering purposes. Of the large percentage of impurities which the water contains at such times, a portion is doubtless made up of sewage from the city that has backed up to the point of intake. The city authorities have for several years looked about for a better source of supply, but as yet no improvements have been made.

Wills Creek is one of the most important tributaries of the North Branch of the Potomac. It flows across the narrowest part of Allegany county, only about 6 miles of the main stream, measuring from the mouth upward, being included within its boundaries. It receives the drainage from portions of Somerset and Bedford counties, Pennsylvania. Much of the catchment area is open, cleared, or cultivated land, and there is a considerable population residing within the area deriving support from coal-mining, brick-making, and similar indus-

tries, as well as agriculture. The discharge of this creek, on September 28, 1897, was 12.5 second-feet; on May 12, 1898, at Cumberland, the flow was 381 second-feet, and on the next day 368 second-feet. The waters are polluted by the drainage from about twenty coal mines and by the refuse from the Cumberland Paper Company, manufacturers of manila and fiber papers. The water is taken from Wills Creek for the digesters, but as it contains too much sulphur for the boilers a supply for steam purposes is obtained from Braddocks Run.

Below Wills Creek and down to the confluence with the South Branch, two tributaries are received—Evitts Creek from the north and Patterson Creek from the south. The discharge of the former at its mouth, on September 25, 1897, was 21 second-feet, and of the latter 12.3 second-feet. There are a few small mills along these streams, but no indication of pollution of the water.

East of Evitts Creek is a small stream known as Frog Hollow, the water of which is taken under the canal above Lock No. 71 by a small culvert. The discharge, on September 25, 1897, was about 0.1 of a second-foot. During the summer the water disappears altogether.

Below the junction of the North and South forks is Town Creek, which receives the drainage of a considerable portion of the eastern part of Allegany county, its headwaters being in Bedford county, Pennsylvania. It is a clear, beautiful stream, its waters not being polluted. There are reported to be two mills on this creek, beside several good waterpowers as yet undeveloped. The discharge, on September 25, 1897, was 11 second-feet. Pursley Run, which discharges opposite Pawpaw, and 15-mile Creek, which discharges near Little Orleans, are small streams with turbid waters. Each of these creeks, on September 26, 1897, was flowing about .5 of a second-foot. The eastern boundary of the county is formed by Sideling Creek, which rises in Bedford county, Pennsylvania, and furnishes power to several grist-mills and sawmills. Its waters are clear and not polluted. The discharge, on September 26, 1897, was 1 second-foot. Back water from a dam in the Potomac extends up the mouth of this creek, the measurement just noted being made above the head of this.

THE MAGNETIC DECLINATION IN ALLEGANY COUNTY

BY
L. A. BAUER

Magnetic observations for the purpose of determining the magnetic declination of the needle, or the "variation of the compass," have been made by the Maryland Geological Survey at various points within the county or along its boundaries. The values obtained thus far are given in the tables below. For a description of the methods and instruments used, reference must be made to the "First Report upon Magnetic Work in Maryland," Vol. I, Maryland Geological Survey Report. This report gives likewise an historical account of the phenomena of the compass needle and discusses fully the difficulties encountered by the surveyor on account of the many fluctuations to which the compass needle is subject. Surveyors of the county desiring a copy of this report should address the State Geologist.

TABLE I.—MAGNETIC DECLINATIONS OBSERVED BY L. A. BAUER, WITH U. S. COAST AND GEODETIC SURVEY MAGNETOMETER No. 18.

No	Station.	Latitude.	Longitude.	Date.	Magnetic Declination.		Remarks.
					At date (West).	On Jan. 1, 1900 (West).	
1	Cumberland..	39 39	78 46	Oct. 10, 1896	4 02.7	4 12.4	Camp Hill.
2	" ..	39 40	78 46	Aug. 14, 1897	4 06.4	4 13.5	South meridian stone, Poor House Farm.
3	Westernport..	39 29	79 02	Aug. 3, 1897	3 46.2	3 53.4	
4	Lonaconing ..	39 34	78 59	Aug. 31, 1898	3 51.0	3 55.0	
5	Paw-Paw.....	39 32	78 26	June 12, 1899	4 10.8	4 12.4	In W. Virginia.

TABLE II.—MAGNETIC DECLINATIONS ALONG BOUNDARY LINE BETWEEN ALLEGANY AND GARRETT COUNTIES, MARYLAND.

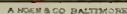
No.	Station.	Latitude.	Longitude.	West Declination on July 1, 1898.	West Declination on Jan. 1, 1900.
		° /	° /	° /	° /
1	Mound 1	39 43.4	78 54.8	4 07.7	4 12.2
2	" 2	39 42.5	78 55.4	4 06.5	4 11.0
3	Sampson Rock	39 42.4	78 55.7	3 58.4	4 02.9
4	Mound 4	39 41.2	78 56.1	4 04.1	4 08.6
5	" 5	39 40.5	78 56.6	4 04.7	4 09.2
6	" 7	39 39.3	78 57.3	3 59.9	4 04.4
7	" 8	39 38.6	78 57.7	3 59.3	4 03.8
8	" 9	39 37.9	78 58.2	4 03.4	4 07.9
9	" 10	39 37.3	78 58.5	3 57.9	4 02.4
10	" 13	39 35.7	78 59.5	3 53.3	3 57.8
11	" 14	39 35.1	78 59.9	3 54.3	3 58.8
12	" 15	39 34.7	79 00.1	3 54.6	3 59.1
13	" 18	39 33.0	79 01.2	3 56.4	4 00.9
14	" 19	39 32.8	79 01.3	3 55.6	4 00.1
15	" 21	39 31.8	79 01.9	3 51.3	3 55.8
16	" 22	39 31.0	79 02.4	3 51.2	3 55.7
17	" 23	39 30.1	79 03.0	3 48.5	3 53.0
18	" 24	39 29.7	79 03.3	3 47.5	3 52.0
19	" 26	39 28.8	79 04.0	3 40.1	3 44.6
20	" 27	39 28.8	79 04.0	3 07.1	3 11.6
21	Daniells Δ	39 28.0	79 02.7	3 11.1	3 15.6

These observations were made in connection with the survey of the boundary line in the summer of 1898, L. A. Bauer being Chief of Party and W. M. Brown, observer. Mr. Brown's readings taken with the needle to his engineer's transit were reduced to the mean of day and referred to the Coast and Geodetic Survey magnetometer No. 18. See Report on the Boundary Line.

DESCRIPTION OF STATIONS.

TABLE I.

1. CUMBERLAND.—In the large, open area on Camp Hill, north of Rose Hill Cemetery and south of Wills Creek. To find station, go 75 paces along the north iron fence of cemetery, starting from northeast corner, then 75 paces at right angles towards Wills Creek. According to town map, this area is subdivided into lots and streets, but no sign of the latter on the ground at present. Station may have been between Sedgewick and Niagara Streets. According to the map it is about 4,667 feet due west of middle point of Decatur Street, on which Mosman's astronomical and magnetic stations of 1864 were located. Station is also about 2,744 feet west of court house and



about 1,280 feet north, and may possibly be over a cement mine. Site was selected in the absence of the County Surveyor by Thomas L. Patterson.

2. CUMBERLAND.—At the South Meridian Stone of the County Meridian Line on the Poor House Farm. [See Report of Establishment of Meridian Line.]

3. WESTERNPORT.—On the north side of hill, along road leading down to the river from W. Va. R. R. station, and about 100 yards east of last house.

4. LONACONING.—In the south part of baseball field, south of Maryland Coal Company's office. The precise point is marked by a locust stake and can be pointed out by Mr. F. E. Bracket, Superintendent of the Coal Company.

5. PAW-PAW.—Morgan County, W. Va., near the frame house, on the hill in the large, open field opposite the R. R. station. The precise point was 37 feet from northwest corner of fence, 67 feet from northeast corner, and 29 feet in front of gate.

TABLE II.

1. Mound on Mason and Dixon line. "On the summit of Big Backbone or Savage mountain, where that mountain is crossed by Mason's and Dixon's line." Reached by mountain road from Mount Savage railroad station. A more roundabout way, but a better road, is from Frostburg by way of Finzell postoffice. The gate-house of the Standard Oil Pipe Line is about 50 yards to the north of the mound. The mound, consisting of stone entirely, was built between two rocky ledges. No hole could be dug, as the precise point was in the crevice of a large, deeply embedded sandstone rock. The subsurface marks are two iron expansion bolts¹ in this rock, one of the bolts being 9 inches to the east of the precise point, and the other 9 inches to the west. The precise subsurface point is therefore midway between the crosses on the bolts. The crevice was enlarged sufficiently so that the surface stone (a rough sandstone 3 feet high and about 70 inches square) could be wedged into the lower rock. Around this stone was thrown up a substantial mound consisting, in the absence of earth, of large and small stones. A half-inch hole in the top of the stone marks the precise point. In order that this stone might be replaced easily in case it should be thrown out of position in some manner, two good solid sandstone rocks jutting out of the ground along the line were marked by iron expansion bolts placed in true line. The first bolt is 15.18 feet back of hole in stone; the second, 22.84 feet in front of it (toward mouth of Savage river). Besides this a bolt was placed forward in line in sandstone rock 154¾ feet.

2. Mound on Mount Savage fire-clay hill. About 500 feet from second dump on fire-clay incline plane. Most easily reached from Mount Savage or from Finzell. Marking stone is 3½ feet high and 8 x 10 inches square, with a hole in top marking precise center. Mound, trench, subsurface stone as prescribed. Pitch pine tree 18 inches in diameter stands about 9 feet north of mound.

3. Mound on Piney Hill, better known as Cranberry Hill. About 300 feet

¹ These bolts wedge tight in driving; the head is one inch square, and they are ½ inch in diameter and 2½ inches long.

east of mountain road known as Cranberry road, running north from National Pike to fire-clay mine. The subsurface stone is about 5 inches thick with center marked on it; on this was placed a stone $2\frac{1}{2}$ feet high and 5×10 inches square with hole in top. Mound and trench around the stone as usual.

4. Mound on Roaring Hill. About $\frac{3}{4}$ mile north of National Pike, where old toll-gate formerly was, not far from house occupied at present by John Workman. A subsurface stone (with center), mound and trench as usual. The upper stone is 2 feet long and 5×12 inches square, the longer dimension being along the line. A drill hole started in top of stone marks precise point.

5. Mound on National Pike. $1\frac{1}{2}$ mile from Frostburg, on south side of pike and about 56 feet west of iron columns marking site of old toll-gate. The principal stone is dressed, of white marble, 3 feet long and 6×6 inches square, with corners rounded off to prevent chipping. A $\frac{1}{4}$ -inch hole in top marks precise point, and the top of stone is lettered as follows:

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: Md. G. S. :
:   —   :
:  1898  :
: ..... :

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On the east side of stone is the letter A and on the west side G. The monument rests on a flat rock (the subsurface mark) and is set in a mixture of broken stone and hydraulic cement. The usual mound and trench surround the monument.

6. Mound on hill south of National Pike. About $\frac{3}{4}$ of a mile south of pike, between two runs, on level piece of cleared ground near an old road and near Frostburg pipe line for water supply, and not many feet west of artesian well. The upper rock is $2\frac{1}{2}$ feet long and about 6 inches square on top. A drill hole started in top marks center. Subsurface stone, mound (9 feet in diameter) and trench as usual.

7. Mound near old Braddock road, on hill north of Winebrenner Run, $1\frac{1}{2}$ mile north of Midlothian. The mound is about 50 yards north of the Braddock road. The upper stone is about 3 feet long, 8 inches square, rudely dressed and with center marked in top. Subsurface mark, mound and trench as prescribed.

8. Mound on hill south of Winebrenner Run. $\frac{3}{4}$ of a mile northwest of Midlothian. On the face of hill sloping toward N. E. upon lower part of spur, about half-way to top of hill and near an old log road, one quarter of a mile south of Benjamin Filer's house, which is in sight. The upper stone is 2.2 feet long and 8 inches square on top with center marked. Subsurface stone, mound and trench as usual.

9. Mound on hill north of Staub Run. About $\frac{3}{4}$ of a mile northwest of Carlos, on farm belonging to William Filer. In the woods, about 100 yards south of rail fence at brow of hill, where miner's path intersects fence. This path leads down to road coming out at Carlos. The upper stone is a red sandstone, about 5 inches thick and about $2\frac{1}{2}$ feet long, with hole drilled in top. Subsurface stone, mound, trench. Mound had to consist chiefly of stone.

10. First mound on hill south of Staub Run. About $\frac{3}{4}$ of a mile west of Carlos. Take road as far as William Filer's house, then follow miner's path to mine opening about $\frac{1}{2}$ mile, then bear to the right to cutting. The hill belongs to the Consolidation Coal Company.

11. Second mound on hill south of Staub Run. About 268 paces south of first mound. The two mounds were placed so near to each other so as to give intervisible points to the north and south. From north mound, mounds 9, 7, 4 and 1 are visible (or can be made so), and from south mound No. 12 can be seen.

12. Mound on north side of Koontz Hill. South of Wright's Run and reached from either Lonaconing, Midland or Ocean. A road passes within 20 yards of the mound and continues northward on down the hill to Ocean, or southward past Cutter's barn down the hill to Lonaconing. Not a very good looking stone, but a substantial one. forms the principal stone. The mound consists chiefly of stone.

13. Mound on south side of Koontz Hill. About 2 miles northwest of Lonaconing. On the south side of lane leading to the west of gate to Cutter's barn and house, and 70 yards from the gate. The farm belongs to the New Central Coal Co., and is rented by Barney Cutter, whose brother, Henry, is at present living on the place. The precise point is marked by a cross cut in stone, $3\frac{1}{2}$ feet long and about 7×7 inches square. In center of cross was drilled a $\frac{1}{8}$ -inch hole. From this mound, mound No. 15 can be seen by planting a pole on top of it.

14. Mound on Pea Ridge road. On the north side of the road leading from Lonaconing to Pea Ridge, about $1\frac{1}{2}$ mile from Lonaconing. Center stone is about 13 inches square and about $3\frac{1}{2}$ feet long, resting about 2 feet in the ground. Precise point was marked with a pick in center of stone. No subsurface mark. Mound about $1\frac{1}{2}$ foot high and 6 feet in diameter, consisting of earth and stone thrown up against center stone.

15. Mound on hill west of Lonaconing. On property of Maryland Coal Company; near fence on west side of meadow south of house occupied by Mr. Weir, who is the present tenant of the farm. Precise point is marked by a cross and $\frac{1}{4}$ -inch hole in center of top of central stone of mound. Subsurface stone, mound and trench as usual. From this mound are visible several points in the line as far south as Franklin Hill.

16. Mound on Detmold Hill. On the west end and on the highest point of the hill. Reached by Miller road running from Detmold to Grantsville, within about $\frac{1}{4}$ of a mile to the west of mound. Mound is built on an undisturbed, solid stone with subsurface mark on it, and around a smooth, upright stone, 3 feet long and 6×9 inches on top.

17. Mound near Miller Road. South of Detmold Hill, between Laurel Run and Miller Road, which runs from George's Creek road to Grantsville; one rod north of road and about $\frac{1}{4}$ of a mile from Robert Green's farm. The precise point is marked by a hole in the central stone, which is 3 feet long and 8×10 inches on top. Subsurface mark, mound, trench.

18. Stone on North Pickell Hill. About $\frac{1}{4}$ mile to the north of next mound (No. 19). No mound was built, but simply a stone 2 feet long and 4×14 inches on top was set in the ground and stones firmly packed around it. The stone is north of a road to meadow on hill. Coal mines are on fire on this hill.

19. Mound on South Pickell Hill. Reached from Barton by taking county road to Grantsville, or also from Moseow, mound being about 2 miles west of latter point. Constructed in the usual manner. Precise point is a cross cut in top of central stone.

20. Mound on Bartlett Road. On county road leading from Barton to Grantsville, about $1\frac{1}{2}$ rod north of road, on land owned by Wm. Sommer-ville. Constructed in the prescribed manner.

21. Mound on Swanton Hill. Reached from Barton by a very steep road to top of hill. Mound is about 40 paces north of barbed-wire fence dividing the American Coal Co. property from that of the Swanton Coal Co. The precise location can be pointed out by Peter Shaw, who lives on top of hill. The central stone of the mound has a cross cut in the top and the letters A and G rudely cut in the sides. Franklin Hill mound (No. 24) can be seen from this point; also No. 15.

22. Mound on Phoenix Hill. Reached from Morrison switch by taking Phoenix Hill road. It is on the summit of the hill in a meadow owned by Davis Coal Co. and leased by John Lannon. Built in the usual manner.

23. Monument on county road south of Phoenix Hill. Reached from Franklin railroad station. On the north side of the road. A good, substantial stone firmly set in the ground and smaller stones packed around it. The mound is about three rods east of U. P. Gannon's house.

24. Mound on north side of Franklin Hill. On the highest point of the hill reached by the line. About 50 feet to the south the hill breaks off very abruptly and only a short distance beyond the tramway curves around the hill to the west. The central stone is about $2\frac{1}{2}$ feet long and about 12 inches square. A cross cut in the top marks the precise point. Subsurface stone, mound and trench.

25. Mound on south side of Franklin Hill. About 20 yards north of county road where it crosses bridge over the Davis coal mine plane. The subsurface mark is a cross cut in a sandstone about $1\frac{1}{2}$ foot long, 8 inches wide and 10 inches thick, lying with the longer dimension at right angles to the line. On this solid stone rests a dressed marble post $2\frac{1}{2}$ feet long and 6 inches square. Around the stone is a mound 8 feet in diameter, consisting of earth and stone; a trench encircles the mound. The stone is lettered on top:

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: Md. G. S. :
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On the west side is the letter G and on the east side A. The precise center is marked by a half-inch hole drilled in the top of the stone.

26. Mound at mouth of the Savage. On the south side of the road leading to Bloomington about 100 feet above the Savage River. The central stone is a dressed marble post, $2\frac{1}{2}$ feet long and 6 inches square, marked and lettered as in the case of No. 24.

27. Bolt in rock at mouth of Savage River. Set with plaster of Paris in a good, firm rock close to the river. Bolt is $\frac{3}{4}$ inch in diameter; head about $1\frac{1}{4}$ inch round. For references and distances to other marks at the mouth of the Savage, see page 33.

ON THE ESTABLISHMENT OF THE SURVEYOR'S MERIDIAN LINE AT CUMBERLAND.¹

In compliance with the instructions received by the State Geologist from the Board of County Commissioners through their clerk, Mr. W. J. Miller, under the date of July 21, 1897, the writer established and permanently marked a true meridian line in Cumberland, August 13-14, 1897. An act of the Assembly, passed at the session of 1870² and codified in 1882,³ authorizes the County Commissioners to have such a line established at the expense of the county.

Test observations made in the City Park, near the court house, where an unofficial meridian line had already been marked by the U. S. Geological Survey, proved conclusively that this site was not a suitable one for the objects of a surveyor's meridian line.⁴ Upon the suggestion of Mr. Thomas Patterson, it was finally decided to put the line on the County Poor House Farm. When subsequently informed, Governor Lowndes signified his approval of the selected site.

The method employed in obtaining the meridian line was that of alt-azimuth observations on the sun; these observations were made on August 14, 1897, the same instruments⁵ being used as in the magnetic work of the Maryland Geological Survey. The accuracy aimed at was that the meridian line shall be correct to one minute.

The monuments marking the ends of the line, which is 404.94 feet long, as substantial granite posts 7 inches square and 4½ feet long; they are suitably lettered and firmly planted. In the center of each monument is leaded a brass dowel, 1 inch in diameter and 3 inches in

¹ A MS. copy of this report was forwarded to the County Commissioners upon the completion of the work.

² Laws of Maryland, 1870, chapter 359.

³ Maryland Code, 1888, vol. i, art. 25, sections 77-82.

⁴ An electric car line passes directly in front of the park. Magnetic observations made in the vicinity of the south meridian stone of the U. S. Geological Survey Line gives the value of the magnetic declination fully ¼° too high.

⁵ The instruments belong to the U. S. Coast and Geodetic Survey and have been loaned temporarily to the Maryland Geological Survey. For descriptions and illustrations of them, see Maryland Geological Survey Report, vol. i, part v.

length. *The line passing through the centers of the crosses cut on these bolts is the true north and south line.*

The magnetic declination (variation of the compass) reduced to its average value for the day (24 hours) was found to be at the *south, or reference, monument*:

Date.	Amount.
August 14, 1897	4° 06.4' west.

This, as will be seen by referring to Table I. agrees very well with the value that was obtained on October 10, 1896, on Camp Hill, near Rose Hill Cemetery, viz., 4° 02'.7. If we refer this value to August 14, 1897, we get 4° 05'.2. It would seem, therefore, that the site selected on the County Poor House Farm is free of local disturbing influences.

The annual change of the magnetic declination may be taken to be at the present time as:

3' (three minutes).

The table¹ below shows how the magnetic declination has changed at Cumberland between the years 1750 and 1900.

Year.	Needle pointed	Year.	Needle pointed	Year.	Needle pointed
	° /		° /		° /
1750	2 03 W.	1800	0 42 E.	1850	0 49 W.
1755	1 41 W.	1805	0 45 E.	1855	1 08 W.
1760	1 22 W.	1810	0 46 E.	1860	1 27 W.
1765	1 03 W.	1815	0 45 E.	1865	1 47 W.
1770	0 41 W.	1820	0 43 E.	1870	2 08 W.
1775	0 21 W.	1825	0 33 E.	1875	2 29 W.
1780	0 02 W.	1830	0 20 E.	1880	2 50 W.
1785	0 13 E.	1835	0 03 E.	1885	3 11 W.
1790	0 25 E.	1840	0 15 W.	1890	3 32 W.
1795	0 35 E.	1845	0 33 W.	1895	3 53 W.
1800	0 42 E.	1850	0 49 W.	1900	4 12 W.

These figures enable the surveyor to ascertain the precise amount of change of the magnetic declination or pointing of the compass between any two dates between 1750 and 1900. It should be empha-

¹ Extracted from Report of Maryland Geological Survey, vol. i. pt. v. p. 482.

sized, however, that when applying the quantities thus found in the re-running of old lines, the surveyor should not forget that the table cannot attempt to give the correction to be allowed on account of the error of the compass used in the original survey.

To reduce an observation of the magnetic declination to the mean value for the day of 24 hours, apply the quantities¹ given in the table below with the sign as affixed:

Month.	6 A. M.	7	8	9	10	11	NOON	1	2	3	4	5	6 P. M.
	/	/	/	/	/	/	/	/	/	/	/	/	/
January....	-0.1	+0.2	+1.0	+2.1	+2.4	+1.2	-1.1	-2.5	-2.6	-2.1	-1.3	-0.2	+0.2
February ..	+0.6	+0.7	+1.5	+1.9	+1.4	-0.1	-1.5	-2.1	-2.5	-2.0	-1.2	-0.8	-0.4
March	+1.2	+2.0	+3.0	+2.8	+1.6	-0.6	-2.5	-3.4	-3.7	-3.3	-2.3	-1.2	-0.5
April	+2.5	+3.1	+3.4	+2.6	+0.8	-2.1	-4.0	-4.1	-4.2	-3.6	-2.3	-1.2	-0.2
May	+3.0	+3.8	+3.9	+2.6	+0.1	-2.4	-4.0	-5.0	-4.5	-3.6	-2.3	-0.9	+0.1
June	+2.9	+4.4	+4.4	+3.3	+1.1	-2.0	-3.6	-4.5	-4.5	-3.8	-2.6	-1.2	-0.2
July	+3.1	+4.6	+4.9	+3.9	+1.8	-1.2	-3.4	-4.4	-4.7	-4.2	-2.8	-1.3	-0.3
August	+2.9	+4.9	+5.4	+3.7	+0.4	-2.8	-4.7	-5.1	-4.9	-3.7	-1.9	-0.6	+0.3
September ..	+1.8	+2.8	+3.4	+2.5	+0.3	-2.7	-4.4	-4.6	-4.2	-4.0	-1.4	-0.3	-0.1
October....	+0.5	+1.6	+3.1	+2.8	+1.4	-1.0	-2.7	-3.3	-3.4	-2.4	-1.3	-0.4	-0.4
November..	+0.5	+1.2	+1.7	+1.8	+1.1	-0.5	-2.0	-2.7	-2.6	-1.8	-1.0	-0.2	+0.2
December..	+0.2	+0.3	+0.8	+1.8	+1.8	0.0	-1.6	-2.4	-2.3	-1.8	-1.1	-0.3	+0.1

TRUE BEARINGS TAKEN AT SOUTH MERIDIAN STONE.

Tip of Court House Tower.....12° 28' E. of S.
 Spire of St. Patrick's Catholic Church, middle
 of ball (♂)31 53 E. of S.

The latitude of the south meridian stone may be taken to be 39° 40' and the longitude 76° 46' W. of Greenwich or 1° 45' W. of Washington. To obtain true local mean time, subtract from eastern or standard time 15 minutes and 4 seconds.

In conclusion, it may be well to state the purposes of the meridian line. They are:

1. To enable the surveyor to determine readily at any time the declination or the "variation of the compass" at the County Seat and thus to provide the means for determining the amount of change.

¹ From Report of Maryland Geological Survey, vol. i, pt. v, p. 457.

2. To furnish a common line whose magnetic bearing from year to year, as well as its true one, has been accurately determined, on which surveyors can from time to time test and compare their compasses.

It gives me great pleasure to acknowledge the able assistance rendered in the establishment of the line by Messrs. Patterson and Shriver, surveyors.

THE FORESTS OF ALLEGANY COUNTY

BY

GEO. B. SUDWORTH

INTRODUCTION.

An explanation of the circumstances under which this investigation took place seems proper. The earnest desire of Professor William B. Clark, State Geologist of Maryland, to develop all the economic resources of the state, naturally led to a consideration of the forests. The writer was detailed to examine the forests of Allegany county as a beginning of this work. The co-operation of the U. S. Division of Forestry in this work was deemed proper on the ground that the information obtained would be of mutual value both to the Division of Forestry and the Maryland Geological Survey.

With the exception of the photographs taken, all expenses attending this field work were defrayed by the Maryland Geological Survey. These photographs, some of which are reproduced for the present paper, number about ninety, and remain the property of the Division of Forestry.

The purpose of this investigation was to supply information as to the condition, composition, character and uses of the forests of this county. The relation of timber-cutting, grazing, and forest fires to reproduction were also subjects of special study, with a view to pointing out a means of abating their evil effects, and thus increasing the productiveness of Allegany forests.

The examination of this county was accomplished by personal travel either on foot, by rail, or by team and wagon. As only the southern and western boundaries of the county are accessible by rail, most of the necessary travel was performed on foot and by team.

The county is well provided with private and public wagon-roads

and trails, giving abundant opportunity for thoroughly exploring the region from east to west and from north to south.

The method of examining the county was, briefly, to gain first a general impression of the topography and location of the wooded portions by inspection from the summits of the highest mountains or hills. A careful study of the various forest growths, the effects of fires, timber-cutting, and mining was then carried out by actual travel over representative portions of the wooded sections, including all of the larger mountains. The photographs taken illustrate the main features studied.

Several county officials and other residents of the county identified with railway and mining interests have kindly supplied important data on the local prices of lumber and the amount of timber consumed for mining props. Thanks are due for such information to Mr. Somerville of Lonaconing, Messrs. Davidson, Armstrong, and B. S. Randolph of Frostburg, and to Mr. J. W. Cook of Cumberland. Special thanks are due Mr. B. S. Randolph for his cordial attention to the writer while visiting the mines and timberlands of the Consolidation Coal Company.

LOCATION.

Washington, Allegany and Garrett counties form the western, tongue-like portion of Maryland. Allegany county constitutes the middle or narrowest section, with Garrett on the west and Washington on the east. The south boundary of Allegany county is defined by the Potomac river; the east boundary, by Sideling Hill Creek; the north boundary, by Pennsylvania (roughly between longitude $78^{\circ} 20'$ and $79^{\circ} 55'$); while the west boundary is formed by a straight line from the crest of Savage Mountain at the Mason and Dixon Line to the mouth of Savage river.

The area of this county is 477 square miles, or 305,280 acres.

TOPOGRAPHIC FEATURES.

The surface of this county is uniformly broken into low mountains and hills, trending mostly in a northeasterly and southwesterly



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direction. The intervening valleys are, for the most part, narrow, merging into low foothills which form the lower slopes to the higher mountains.

The salient features in the topography are the long high ridges known as Town Hill, Warrior Ridge, Wills Mountain and Dans Mountain. Sideling Hill and Savage Mountain are equally prominent barriers on the east and west, but are mainly outside of Allegany county. The west boundary of the county lies on the east slope of Savage Mountain, while the east boundary lies at the bottom of the west slope of Sideling Hill. The elevation of these mountains ranges from 1,000 to 2,900 feet.

Most of the larger mountains have long and gradual slopes, including also broad flat benches at elevations of 800 to 1,200 feet. Less commonly, the mountain slopes are precipitous, notably on the south border of the county. The surface of the mountains and higher hills is often broken by exposed boulders of quartzite and sandstone. The summits of the mountains are marked by mostly bare rocky cliffs.

SOIL.

The soil of nearly all the hills and mountain slopes is thin, being composed largely of fine slaty shale. Cultivated portions are rapidly worn out, and even where the timber grows the soil is often poor in humus. This poor top-soil under forest cover is due partly to a necessarily slow disintegration of the substratum of pure shale and broken rock which lies close to the surface and partly to the frequent forest fires which continually destroy the enriching leaf mould.

The soil of the lower hills and valleys is rocky, but deeper and richer. The best agricultural lands are, therefore, situated mostly in the valleys and on low adjacent hills (Plate XXV, Fig. 2). Considerable land has been cleared on the higher mountain slopes, but it is far less productive than the lower areas.

WATER FLOW.

The county is well watered by numerous rocky streams fed by innumerable cold springs among the low hills and on the higher

mountain sides. All are tributary to the Potomac river. The most important of these streams are Sideling Hill Creek, Fifteen-Mile Creek, Flint river, Town Creek, and Georges Creek. They vary in width from twelve to twenty-five feet and carry from six to fifteen inches of water. At high water their volume is increased to two or three times the normal flow.

The water of most of these streams is pure and wholesome. That of Georges Creek and several of its tributaries is, however, so strongly impregnated with iron, sulphur and drainage from coal and fire-clay mines as to be unwholesome. No fish exist in these waters.

In earlier days these streams supplied waterpower for small saw-mills and flour-mills throughout this region. Few of these mills are in existence now. The flow of streams is chiefly important to farmers in affording an abundant and convenient supply of water for stock. The small transient steam sawmills also depend on this source of water supply. The maintenance of the numerous springs peculiar to this region is of prime importance to nearly all farmers and residents of the smaller towns, many of which depend on this source of water supply.

At present these resources are well protected by forest cover, as are also the headwaters of all the streams draining the county.

As indicating the close relationship, however, between water flow and forest cover it is interesting to note in this connection that the oldest inhabitants of this region assert the existence of a greater rush of water in the spring and fall of recent years than was formerly observed, when the country was more continuously wooded. In earlier times the larger streams are said to have carried a uniform flow, with little or no sudden increase during spring and fall. The heavy rains and melting snow under present conditions, however, occasion an immediate and often dangerous rise of water in the larger streams at certain points. The rise of water sometimes prevents farmers crossing fords for a week or more, thus cutting off their communication with markets, etc. To obviate such difficulties, the county has built a few new roads to avoid impassable fords.

The explanation of this rush of water is simple. Increased, indis-



FIG. 1.—THIN FOREST COVER, POTOMAC RIVER.



FIG. 2.—FARM AND FOREST LAND, MARTIN MOUNTAIN.

FORESTS OF ALLEGANY COUNTY.

criminate clearing of woodland, especially on the larger slopes, brings about a more direct and rapid drainage than was permitted by the original close forest cover of the county.

WOODED REGIONS.

With the exception of a few treeless swampy meadows of small size, the entire county was once a continuous forest. The heaviest timber existed in the coves, on the low hills, and on the lower slopes and benches of the mountains, where the soil is deepest and most porous. The rocky upper slopes and summits appear to have borne a forest of small stunted trees.

The wooded portions of the county are now confined to the larger hills and mountain ridges, with irregular extensions into the valleys. Most of the streams also bear fringes of forest growth. Roughly estimated, the agricultural land of this county is about thirty per cent of the entire area, the remainder being mostly in forests with a small per cent of brush land. The latter, however, contains forest tree species of brush size, and is, therefore, to be classed strictly as reforested land.

The forests of the mountains form for the most part a continuous cover down to the usually cleared valleys (Plate XXV). Only occasional clearings and worn-out, abandoned farms are seen on the mountain sides; but wherever these cleared lands have been long neglected, they are already reforested, or are rapidly becoming so as shown in Plate XXVIII, Fig. 1.

CHARACTER OF THE FORESTS.

The character of the forests, changeable throughout, varies especially from north to south. The prevailing growth is deciduous, but this is conspicuously mingled with patches, and often large areas of conifers, the latter being somewhat more abundant in the central and southern parts of the county.

Small detached hills in these regions bear a pure growth of conifers as seen in the region of Pine Hill and Piney Grove, while portions of surrounding slopes are covered largely with deciduous forest. In

other cases similar hills bear a growth chiefly of conifers on their north slopes and a deciduous forest on their south slopes. As a rule the larger mountain slopes bear a variously mixed growth of conifers and deciduous trees, sometimes evenly mingled or with the conifers in alternating vertical belts. The slopes near the larger waterways also bear conspicuous fringes of conifers, which give way to the hardwoods higher up on adjacent slopes.

COMPOSITION OF FORESTS.

The peculiar position of Western Maryland, intermediate between the North and the South, gives Allegany county a forest flora rich in species. The higher summits, coves and valleys exhibit a climate and soils closely similar to those of the more northern states, while the climate and soils of the lower valleys, glades and hills are characteristic also of the adjacent southern states. As a result, there is a conspicuous association of northern and southern tree species. This association is of more than passing interest, since the kinds represented are of economic importance. Conifers and hardwoods of the middle South and North mingle here almost on the same ground.

The following is a complete list of coniferous and hardwood trees of Allegany county:

CONIFERS.

1. White Pine *Pinus strobus.*
2. Pitch Pine *Pinus rigida.*
3. Scrub Pine *Pinus virginiana.*
4. Table-Mountain Pine *Pinus pungens.*
5. Shortleaf Pine *Pinus echinata.*
6. Hemlock *Tsuga canadensis.*
7. Red Juniper *Juniperus virginiana.*

HARDWOODS.

8. Butternut *Juglans cinerea.*
9. Black Walnut *Juglans nigra.*
10. Bitternut Hickory *Hicoria minima.*
11. Shagbark Hickory *Hicoria ovata.*
12. Mockernut Hickory *Hicoria alba.*
13. Pignut Hickory *Hicoria glabra.*
14. Small Pignut Hickory *Hicoria odorata.*
15. White Willow *Salix alba.*
16. Large-tooth Aspen *Populus grandidentata.*
17. River Birch *Betula nigra.*
18. Sweet Birch *Betula lenta.*
19. Hornbeam *Ostrya virginiana.*

20. Blue Beech.....	<i>Carpinus caroliniana.</i>
21. Beech.....	<i>Fagus atropurpurea.</i>
22. Chestnut.....	<i>Castanea dentata.</i>
23. White Oak.....	<i>Quercus alba.</i>
24. Post Oak.....	<i>Quercus minor.</i>
25. Chestnut Oak.....	<i>Quercus prinus.</i>
26. Swamp White Oak.....	<i>Quercus platanioides.</i>
27. Red Oak.....	<i>Quercus rubra.</i>
28. Scarlet Oak.....	<i>Quercus coccinea.</i>
29. Yellow Oak.....	<i>Quercus velutina.</i>
30. Pin Oak.....	<i>Quercus palustris.</i>
31. Barren Oak.....	<i>Quercus pumila.</i>
32. Slippery Elm.....	<i>Ulmus pubescens.</i>
33. American Elm.....	<i>Ulmus americana.</i>
34. Hackberry.....	<i>Celtis occidentalis.</i>
35. Red Mulberry.....	<i>Morus rubra.</i>
36. Cucumber-tree.....	<i>Magnolia acuminata.</i>
37. Tulip-tree.....	<i>Liriodendron tulipifera.</i>
38. Papaw.....	<i>Asimina triloba.</i>
39. Sassafras.....	<i>Sassafras sassafras.</i>
40. Witch Hazel.....	<i>Hamamelis virginiana.</i>
41. Sycamore.....	<i>Platanus occidentalis.</i>
42. Sweet Crab.....	<i>Pyrus coronaria.</i>
43. Serviceberry.....	<i>Amelanchier canadensis.</i>
44. Cockspur.....	<i>Crataegus crus-galli.</i>
45. Scarlet Haw.....	<i>Crataegus coccinea.</i>
46. Pear Haw.....	<i>Crataegus tomentosa.</i>
47. Small-leaf Haw.....	<i>Crataegus uniflora.</i>
48. Wild Plum.....	<i>Prunus americana.</i>
49. Wild Red Cherry.....	<i>Prunus pennsylvanica.</i>
50. Sour Cherry.....	<i>Prunus cerasus.</i>
51. Black Cherry.....	<i>Prunus serotina.</i>
52. Redbud.....	<i>Cercis canadensis.</i>
53. Honey Locust.....	<i>Gleditsia triacanthos.</i>
54. Locust.....	<i>Robinia pseudacacia.</i>
55. Ailanthus.....	<i>Ailanthus grandifolia.</i>
56. Staghorn Sumach.....	<i>Rhus hirta.</i>
57. Dwarf Sumach.....	<i>Rhus copallina.</i>
58. Mountain Maple.....	<i>Acer spicatum.</i>
59. Striped Maple.....	<i>Acer pennsylvanicum.</i>
60. Sugar Maple.....	<i>Acer saccharum.</i>
61. Silver Maple.....	<i>Acer saccharinum.</i>
62. Red Maple.....	<i>Acer rubrum.</i>
63. White Basswood.....	<i>Tilia heterophylla.</i>
64. Dogwood.....	<i>Cornus florida.</i>
65. Black Gum.....	<i>Nyssa sylvatica.</i>
66. Mountain Laurel.....	<i>Kalmia latifolia.</i>
67. Rhododendron.....	<i>Rhododendron maximum.</i>
68. Persimmon.....	<i>Diospyros virginiana.</i>
69. Black Ash.....	<i>Fraxinus nigra.</i>
70. White Ash.....	<i>Fraxinus americana.</i>
71. Green Ash.....	<i>Fraxinus lanceolata.</i>
72. Nannyberry.....	<i>Viburnum prunifolium.</i>

GENERAL DISTRIBUTION OF FOREST TREES.

The limitation of certain trees to particular areas forms somewhat conspicuous features in the composition of the forests of this region. There are, of course, no very sharp lines of separation between the

ranges of tree species, but within general limits, at which there is more or less overlapping or mingling of two or more species, it may be noticed that finally one kind of tree disappears and another appears. For example, in ascending one side of a mountain, Beech, Maple, Basswood, etc., may appear at the base of the mountain. Above these a succeeding zone may contain Chestnut, Sweet Birch, etc.; and the next higher zone, Chestnut Oak, Table-mountain Pine, Wild Red Cherry, etc. These zones blend into each other more or less by the mingling of the trees peculiar to each zone. Similarly defined areas of tree growth of still other species may be met with on the opposite slope of the same mountain. Or in passing from deep valleys on a mountain side to adjoining ridges or benches at the same altitude, often there may be found an assemblage of trees peculiar to each of these dissimilar localities.

The explanation of these phenomena is believed to lie in the fact that certain trees have become so completely adapted to a given kind or condition of soil (dry, moist, loose or compact), or climate, that they cannot exist where the required soil and climate are wanting. Thus the presence of a northern climate in portions of this region appears to account for the presence, by extension, of northern trees into this county which are prevalent in their wider northern range under the same conditions. The more cosmopolitan trees of this region are conspicuous over a greater area, while the less widely adapted kinds appear within narrower limits.

The part also which some trees and shrubs play by taking first possession of denuded lands, thus rendering the soil favorable by protection of moisture for the introduction of still other trees, is a most interesting and practical consideration in the distribution of trees. This is especially true where fire and the axe have destroyed a part or the whole of an original forest. The full value of all the trees in a region cannot be determined without a knowledge of the relationship of species in their natural succession.

DISTRIBUTION OF PRINCIPAL TIMBER TREES.

The most conspicuous of the timber species are the White Oak, Chestnut Oak, Red Oak, Chestnut and White Pine. They form



FIG. 1.—WOODED HILL IN SOUTHWESTERN ALLEGANY COUNTY.



FIG. 2.—NARROW AGRICULTURAL VALLEY IN SOUTHEASTERN ALLEGANY COUNTY.

forests in which, according to exposure and altitude, the one or the other predominates; in fewer instances areas occur with mixtures of all five species, together with other kinds which do not form forests.

The *White Oak* occurs on all the low hills and on the lower and middle slopes and benches of the high mountains. Originally it also occupied the high valleys now cleared. Its presence usually indicates the deeper, richer, and less rocky soils.

The *Chestnut Oak* appears commonly on all the upper, rocky, gravelly slopes and summits of the mountains and hills. It grows persistently even on precipitous slopes where the surface consists entirely of broken quartzite and sandstone; but here the trunks are short and gnarled. The larger and better formed trees are found where the rock is broken and carries a thin cover of soil. The White and Chestnut Oak often occur together, but in most cases the one or the other prevails under the peculiar conditions which suit it best. Few and scattering White Oaks are found on the rocky sites chosen by the Chestnut Oak, and *vice versa*.

Chestnut is confined chiefly to poor, dry, gravelly, southern, eastern and western slopes. It is sometimes mingled with Chestnut Oak, but more often constitutes the principal growth over a considerable area, giving way in richer moist coves and on benches to White Oak and other hardwoods, and appearing again on the thinner soils. As with Chestnut Oak, the best growth occurs on the middle and lower slopes; that found on and near the summits of the mountains is short and of small diameter.

The *Red Oak* is a constant associate of the White Oak, Chestnut Oak and Chestnut, but far less abundant than these species. In stands of 60 to 80 trees to the acre the Red Oak forms only from five to ten per cent. It is a tree singularly well adapted to a variety of soils, often producing well-formed trunks even in the deep crevices of almost bare rock. The largest trees occur in rich coves and sinks where the underlying rock is broken.

The *White Pine* occurs almost entirely on northern and eastern slopes, ascending to the summits of the highest mountains (Mt. Savage, Warrior Ridge and Dans Mountain). It is especially con-

spicuous along the rocky north slopes of streams, often forming dense, narrow belts of pure growth down to the water's edge (Fig. 14). Higher up on the slopes it is usually mingled with hardwoods. The White Pine forest shown in Fig. 14 is composed chiefly of young timber (25 to 75 years old), ranging from 6 to occasionally 15 inches in diameter, and under 60 feet in height. A much older, scattered growth of this pine is found among hardwoods. Under these conditions the trunks are 18 to 30 inches in diameter



FIG. 14.—Pure growth of white pine, near Flintstone.

and 80 to 100 feet high. The White Pine of this county grows best in moist, well drained, clayey loam soils, such as produce the finest White Oak.

DISTRIBUTION OF SUBORDINATE TIMBER TREES.

The next most conspicuous timber trees are, among conifers, the Pitch Pine, Shortleaf Pine, Table-mountain Pine and Scrub Pine. Of hardwoods, the principal remaining species are Sugar Maple, Red Maple, Shagbark Hickory, Tulip-tree, White Ash, White Basswood, Locust, Black Gum and American Elm. The pines commonly pass

for one species. Together, they constitute an important element in the forest cover of very exposed, bare, rocky, southern slopes.

The *Scrub Pine* forms a dense cover in the poorest shaly soils on the lower southern slopes of the high ridges, or more frequently on the south side of low hills throughout the middle and southern sections of the county (Plate XXVII, Fig. 2). It is peculiarly adapted to exposed, sterile soils, often taking possession of abandoned, worn-out fields to the exclusion of all other species. In richer soils and less exposed localities it gives way to patches of hardwoods. Most of the *Scrub Pine* now standing is of small size, ranging from two to six inches, with occasional trees eight to fourteen inches in diameter. The largest trees which grow on least exposed sites have straight clear trunks twenty to thirty feet long. The growth found on the most exposed, precipitous sites is usually low, crooked, and much branched.

At higher elevations, comprising the middle benches and summits of the mountains, *Pitch* and *Table-mountain Pine* occupy sterile, rocky situations on southern, southeastern and southwestern exposures. Scattered individuals also occur mingled with hardwoods on the low shaly hilltops adjacent to the mountains (Plate XXIX, Figs. 1, 2). Where these pines form the principal growth, the two species are usually mingled in about equal numbers. Not infrequently, however, the *Table-mountain Pine* forms pure open stands of ten to fifty acres on narrow, rocky benches high up on the mountain sides. In exceptional instances also, stunted *Shortleaf Pine* is to be seen among these mountain groves, notably on Town Hill. Little merchantable timber is produced by the *Pitch Pine* and *Table-mountain Pine*, as their principal growth is low and much branched and the wood coarse-grained and knotty.

The hardwoods of this group appear more or less scattered among the deciduous species already mentioned as forming forests. One of the most abundant of these is the *Sugar Maple*. It occurs in all the moist rocky coves and in the vicinity of streams throughout the county. Its ability to thrive in the seams of almost bare limestone and quartzitic rock is remarkable. Well-formed large trees were

frequently met where only a scanty deposit of soil had filled the narrow crevices in the rock.

Closely associated with the Sugar Maple, but in fewer numbers, are the *Red Maple*, *White Basswood*, *White Ash*, *Shagbark Hickory*, *Locust*, *Tulip-tree* and *Beech*. These scantily represented species form open forests in which none occur abundantly or continuously, but at irregular and often long intervals. These trees were doubtless more abundant in former years. The present economic value of this growth is small, except for fuel, as no considerable yield of any one kind can be secured without very wide culling.

DISTRIBUTION OF OCCASIONAL TIMBER TREES.

Still less prominently represented are a few other valuable timber trees, notably the *Black Walnut*, *Butternut*, *Mockernut* and *Pignut Hickory*, *Swamp White Oak*, *Cucumber-tree*, *Black Cherry*, *Sycamore*, *Black Ash* and *Red Juniper*. Excepting the *Black Ash* and *Swamp White Oak*, which are peculiar only to swampy glades of the high valleys, all of these trees are found as stragglers among the preceding more abundant kinds. Very probably the original forests of this region contained much larger numbers, as the special conditions favorable to their growth are prevalent.

The other trees enumerated are nearly all small and of little importance. They are generally distributed among the more conspicuous forest growth. A few only are confined to certain localities, and interesting because of their rarity in this region, or special usefulness in establishing a cover under which better kinds may grow. Among those species are the *Sweet Birch* and *Wild Red Cherry*, which occur only on the highest summits. The latter is not a tree of economic value and is mentioned only on account of its rarity. The *Sweet Birch* supplies an important furniture wood in mountainous parts of the adjacent states where the rocky soil is deep and rich. The timber produced is of large size. In Allegany county, however, this *Birch* is necessarily small on account of the present extremely sterile soil.

The *Barren Oak* is the most conspicuous of small trees in the



FIG. 1.—SCRUB PINE, NEAR OLDTOWN.



FIG. 2.—DEFECTIVE LARGE WHITE PINE IN YOUNG HARDWOOD, FIFTEEN MILE CREEK.

region. It forms low, dense, brushy thickets high up on the mountains and ridges wherever the original deciduous forests have been entirely cut or burned off. Being partial to the poor, shaly soils of these high elevations, it serves a useful purpose in establishing a ground cover, which prevents violent washing of the soil. Useful timber species soon follow under the protection of the more hardy Barren Oak.

Finally, the Hackberry, Sweet Crab, Thorny Haws, Wild Plum, Serviceberry, Redbud, Nannyberry and Sumachs are small fore-runners in the natural reforestation of abandoned cleared lands in the valleys on the lower hills. Together with briars and other shrubs, these small trees take complete possession of such lands in from ten to fifteen or more years. Following this growth may be seen the slow, sure introduction of the better kinds of forest trees.

IMPORTANT TIMBER TREES: THEIR ABUNDANCE AND USES.

The most abundant and commercially important timber trees of this region are White Pine, Shortleaf Pine, Hemlock, White Oak, Chestnut Oak, Red Oak, Chestnut, Shagbark Hickory, Sugar Maple, White Ash, Tulip-tree, Basswood and Black Walnut. Other species represented supply much useful timber, but occur too sparingly to afford large supplies.

The original forests of this county produced considerable White and Shortleaf Pine and large quantities of White Oak, Yellow Poplar and Hickory timber, together with an abundance of Chestnut Oak and Hemlock tan-bark. The timber was large and of excellent quality, and is estimated to have frequently given an acre yield of from 8,000 to 10,000 board feet, over large areas, or possibly more in some localities.

The old, slow water sawmills made but small inroads upon this supply; but evidence is everywhere present of the nearly complete culling made later by portable steam sawmills (Fig. 15). The latter have so completely lumbered out the large sound timber on all the principal streams, in the once heavily wooded coves and on the rich mountain benches and gentle slopes, that at present sizable timber of good quality is scarce and distant from public roadways.

Most of the large White Pine is now gone. Defective old White Pines are frequently seen scattered over slopes now covered with young hardwood forests (Plate XXVII, Fig. 2); only an occasional sound White Pine is to be found.

Shortleaf Pine is similarly exhausted. Small groups and scattered single trees are to be found in patches of hardwoods on farms in the lower hill country, or forming thin belts skirting the lower slopes of the higher, wooded mountains. Only occasional large



FIG. 15.—Portable steam sawmill.

trees are to be found (Plate XXX, Fig. 1). The majority are now too few or of too small size to furnish any considerable amount of timber.

The saw timber now available consists chiefly of White Oak, Chestnut Oak, Red Oak and Chestnut, with only occasional logs of second growth White Pine, Shortleaf Pine, Pitch Pine, Basswood and Shagbark Hickory. The approximate acre yield of timber now standing amounts to from less than 500 to about 2,000 board feet; exceptional, isolated small bodies would cut from 3,000 to 6,000 feet per acre. These supplies occur, however, at long intervals, and, as already

stated, are profitably reached only by small portable sawmills, which find employment mostly for only a few months in one place. Sizable timber is especially scarce near railways and the principal wagon-roads, over which the original stock has largely been taken.

A few portable sawmills are cutting small quantities of the above-mentioned timber at various points through the northern and middle portions of the county. In some cases the output is a mixed cut of hardwoods and pine, while in other localities the cut is principally either oak or pine. The best quality of lumber produced is oak. The pine cut is very knotty and of second- or third-rate quality. Owing most likely to the absence of convenient railway connections, a comparatively low price, \$8.00 to \$12.50 per 1,000 board feet, is received for the average local output of lumber.

The demand for mining props and railway ties is apparently large and relatively more profitable to the producer than lumber. The output of this material is, however, confined chiefly to localities near the coal and fire-clay mines and the railways in the western part of the county, and to the region of the Baltimore and Ohio Railroad and Chesapeake and Ohio Canal. Poor roads and high hills render it unprofitable to haul such heavy material from the more distant interior sections lying to the north.

The mining props cut show that nearly all the trees of the region contribute to this material. The species commonly cut are White Oak, Chestnut Oak, Scarlet Oak and Red Oak, Shagbark Hickory, Pignut Hickory and Mockernut Hickory, Chestnut, Red Mulberry, Locust, Sugar Maple, Red Maple, Black Gum, White Ash, Black Cherry, White Pine, Pitch Pine, Scrub Pine, Table-mountain Pine and Shortleaf Pine. All are used without distinction, but those most highly prized for their strength and durability are White Oak, Chestnut and Locust. The props range from five to seven inches in diameter at the butt, and are nine feet long. It is rare, therefore, that a tree furnishes more than three props. The present stand of young timber fit for this purpose affords a yield of 35 to 50 props per acre. Where the stand is largely Chestnut and Locust, which is often the case, such cuttings may be made approximately every

ten to fifteen years. For young forests containing mixtures of the other species mentioned, a cutting for mining props can be made in from fifteen to eighteen or more years. Excluding the conifers, much of this material is supplied by coppice sprouts, the Chestnut and Locust far outstripping the other hardwoods in growth. The remainder of the props comes from pole stock, grown from seed, 25 to 30 years old. The annual consumption of mining props in the coal and fire-clay mines of western Allegany county is roughly estimated at about 1,000,000. This represents an annual culling of about 28,000 acres.

The wastefulness of cutting such timber as White Oak, Hickories, Maples, White Ash and White Pine at the short interval of fifteen to eighteen years should be apparent, and will be discussed later. The use of the other less valuable timber species, and especially the rapid growing Chestnut and Locust is more advisable.

This county has produced large quantities of Chestnut Oak tan-bark and considerable Hemlock in the western part. The sources of supply are, however, now greatly diminished or exhausted. No bodies of Hemlock exist in the county. The small quantity of young timber scattered along rocky north slopes of streams in western Allegany, is insufficient to supply tan-bark.

The once abundant stand of Chestnut Oak has likewise been nearly exhausted by bark peelers. The comparative lightness of this product has enabled producers to secure bark from even the steep, rocky slopes of the highest mountains, from which the hauling of heavier saw-timber would have been unprofitable. The large tanning establishment which continued for many years at Gilpintown, in the north central part of the county, had to be abandoned a number of years ago for lack of tan-bark.

With scarcely an exception, the exploitation of tan-bark in the past was attended by a total waste of the timber, and most of the bark peeling of the present time leaves the trunks unused. The only exception observed by the writer was in recent work on the lands of the Consolidated Coal Company in the western part of the county. Here all peeled Chestnut Oak is being sawed up for mining timber with the other timber stripped from coal-bearing land.

RELATION OF LUMBERING AND MINING TO REPRODUCTION.

It would be difficult to find a region in which the useful timber has been more generally removed than in this county, and at the same time, one in which so much forest cover has been left intact. Doubtless only the non-agricultural nature of the greater part of the original forest-bearing regions has prevented an almost complete deforestation. In cutting the timber no pains were taken to assist the reproduction of original timber species. The purpose of all cuttings was the same, whether for sawlogs, tan-bark, ties, or mining props; the largest amount of useful material, regardless of consequences, was the prime object. That all but the twenty-five or thirty per cent of arable land in the county has continued to bear a forest cover, is evidence of the greatest natural persistence in reproduction, which often takes place under very unfavorable conditions.

The reforestation of denuded land in this humid region is, therefore, one of the easiest problems. In spite of abusive methods of lumbering and other cutting there is no evidence of the disappearance of any of the original timber species. A careful study of the young timber and seedlings shows all the old species to be present in the young growth. The absence, however, of large-sized trees of certain species, in fact, sometimes of any but small seedlings, usually suggests to the casual observer that once prevalent trees have permanently disappeared from a region. The fact also that the commercial supply of such timber as White and Shortleaf Pine appears to remain exhausted, may add to the impression that these trees can never again produce the original abundance of timber. But the natural reproduction of these trees in this region is peculiarly good. It required one to two or more hundred years to produce the supply of large White and Shortleaf Pine found in this county forty years ago; and the various stages of struggle between the contending hardwoods and pines for the possession of this ground were unseen by those who cut off the finally dominant pines. Much of the area thus wooded now bears a principally young deciduous forest with only scattered remnants of the once abundant pine; trees which at the time the larger timber was taken escaped the axe either because they

were too defective for use or of undersize. The old defective trees have continued to exist, and the undersized are now large enough for saw-timber, but generally too few to claim attention.

The establishment of another growth of pine like the one removed can be accomplished only by another long struggle. The seed trees left standing are centers of reproduction. But each of the pines must spread under conditions best suited to its reproduction. The White Pine of this county will establish itself in pure growth on cleared land on exceptionally moist, protected, portions of northern slopes, and elsewhere only under the moderate shade of young hardwoods. Once established, however, the young pines do not require further protection; but, as a matter of fact, they must remain suppressed till accident or design removes enough of the hardwoods to allow the pines to grow up.

The Shortleaf Pine must spread from the few seed trees left here and there by pushing into sunny, partly shaded openings among the hardwoods. It makes a successful stand in such places, if it outstrips or keeps up in height growth with the hardwoods.

This reproduction of pine, which is going on now, would, if uninterrupted, require so many years that the generation of settlers who saw and helped to remove the original crop of pine could not witness the perfection of the returning crop. Moreover, the commercial conditions of the region are now greatly changed from those attending the former growth. The present increasing and constant demand for small-sized timber in this region prevents the White or Shortleaf Pine and many other useful timbers from reaching mature growth. Thousands of pine props are made from very young trees, thus cutting off all chance for the production of the more valuable mature timber.

In conclusion, it may be restated that while the present and past cutting of saw-timber, ties, mining props and timber for tan-bark has locally depleted or entirely exhausted the supply of timber, it has not materially changed the composition of the forests now standing. The original species remain, and the hardwoods promptly increase wherever the axe, fire and grazing are withheld: the conifers come back



FIG. 1.—NEGLECTED FARMLAND, EASTERN ALLEGANY COUNTY.

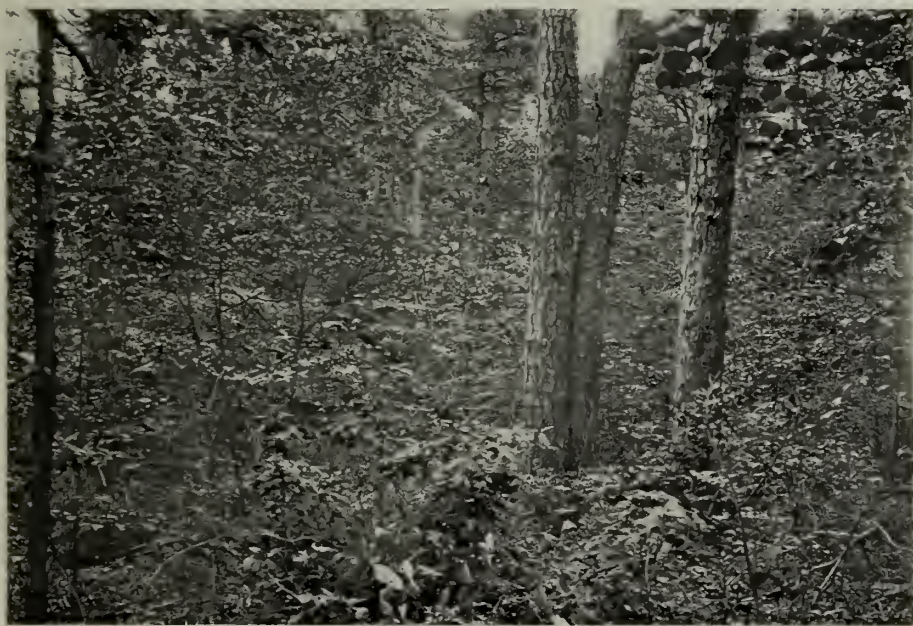


FIG. 2.—SHORTLEAF PINE AND PITCH PINE, TOWN HILL.

FORESTS OF ALLEGANY COUNTY.

more slowly. Moreover, as already shown, where cleared agricultural land is long abandoned, this land quickly reverts to the original forested condition.

It is not to be presumed, however, that with a widespread and complete removal of existing species a serious change would not be made in the composition of the subsequent forest growth. The reproduction of all trees, as with other plants, depends emphatically on the presence of seed trees, be they far from or near the cleared land. But the lumbering and other timber-consuming industries of previous years have by chance left enough seed trees to assure the perpetuation of all species for the present.

The removal of large deposits of coal from beneath wooded areas may permanently change the surface, kill the existing timber and retard subsequent reproduction.

As is well known to those familiar with these coal-mining operations, as much as possible of the big coal-veins, about 6 to 9 feet thick and lying in a horizontal position, is taken out before abandoning the mines. In agricultural regions these worked-out coal-beds may doubtless be left sufficiently shored up by pillars of coal to prevent any collapsing of the surface. In the rougher hill country, however, mostly with brush or forest cover, such expensive precautions are not likely to be taken. The coal is taken out and the surface left to sink or retain its position, as circumstances permit. When coal-beds lie over one hundred feet below the surface, the unsupported cavity seems not to result in any but an irregular depression in the surface. Where the removal of deposits is nearer the surface (30 to 75 feet), the final dropping of the surface is usually violent. Cavernous pits are produced which engulf the forest growth in mingled masses of variously tilted, fallen and upright trunks; but much of this continues to grow. The timber thus involved is almost entirely inaccessible. These breaks in the surface are gradually much smoothed in their more abrupt portions by the washing and sliding of soil and rocks. Smaller vegetation covers the bare spots, and the undermined rough surface is finally overgrown with brush and forest trees.

Wherever coal lands bearing considerable useful timber are controlled by ownership, the usual plan is to remove all usable timber before the coal is mined. This takes all sound trees down to about three inches in diameter. If uninterrupted, the final recovery by original species is well assured. For when carefully examined, the forest floor of such denuded lands is found to contain well established seedlings of the principal timber species from two to ten years old. In addition to these, much of the sapling growth comprising the same kinds survives the destructive lumbering methods employed and also the caving-in of the surface.

The much greater value of the coal deposit must always properly have precedence over the present timber crop lying above, and also over that which would have been possible during the term of years necessary for the land to recuperate from the effects of the undermining. It only remains to be said, therefore, respecting the relationship of coal-mining operations and forest reproduction that there is an appreciable loss in timber production on undermined forest land. The period of this loss will vary, according to the purpose for which the timber rotations are taken, from twenty to one hundred or more years. The actual annual loss of timber growth for the species represented could not be accurately stated without an extended study of the productiveness of abandoned coal lands.

Some permanent damage is also to be mentioned as a result of a fixed change in the surface of undermined forest lands. The inaccessibility of such lands for future lumber operations is greatly increased. In many places the timber is likely to be difficult to get at, and the building of roadways is expensive on so broken a surface.

FOREST FIRES AND THEIR RELATION TO REPRODUCTION.

Forest fires have been widely prevalent in this county, but their effects are not strikingly evident. Types of the widespread and long-enduring devastation so common in the more western timbered states are nowhere seen in this region. However severe the damage done may be, the ravages of Allegany county fires are soon greatly concealed by rapid and abundant reproduction. Moreover, very little large timber appears to have been killed by fire.

Two factors explain the rapid recovery and small injury to large timber. The largest areas of timber land are comprised in the principal mountain ranges. The most prevalent fires have occurred in these localities. Now the principal reason that destructive fires do not occur, is in the fact that there is no deep humus and little accumulated débris to feed a deep burning fire. In its present condition, the soil and humus cover in these forests is only from one to two inches deep and lies on bare rock and shale. Large areas bear no soil or humus at all, except in the crevices of the rock, while elsewhere the bare soil is composed largely of slaty shale.

With very little dry, fallen timber or brush, the fires occurring in these sections are fed mostly by the heavy fall of leaves. The exposed rock and shale immediately beneath permits only a surface fire, which almost never reaches the tree roots lying deep in crevices or beneath the shale.

The ordinary effect upon the larger timber trees is a noticeable but harmless scorching of the thick bark from two to six feet up; the resin-covered trunks of the Table-mountain, Pitch and Shortleaf Pine bear the higher fire marks. The greatest damage to large timber observable within recent times resulted from a fire which occurred about six years ago. Considerable dry, down timber in some localities where selective cutting for saw-timber had been done, attended by a dry season, resulted in an unusually severe fire. Few large trees were killed, but many were badly burned in spots at the collar, evidently from the burning of unused logs and treetops lying near or in contact with green trunks. While these burney trees survived the fire perfectly, the trunks are, as a result of burning, without an exception, decaying at the heart and deteriorating for saw-timber.

The effect of surface fires on seedlings and coppice sprouts is disastrous in killing most growth from one to ten feet high. The thin-barked stems of all species are severely scorched so that they die down to the ground. An encouraging feature is, however, that the roots of seedlings over one year old are rarely killed. They produce vigorous sprouts the following season. The scorching of Chest-

nut and Oak sprouts is often so slight as to kill only the thin bark, leaving the sapwood uninjured; a few immature leaves are then put forth, but the stems finally die down to the ground.

While in general the damage by fires in this region appears not to be great, especially since there is little or no apparent decrease in the forest cover, nevertheless, the combined effects upon all ages of growth are very appreciable. The greatest damage is done in the periodic destruction of from one to ten or more years' growth of seedlings and coppice sprouts. A few very young seedlings are also killed. Clearly, therefore, the productiveness of these forests is much reduced; in fact, where fires run through this young growth at short intervals it is practically held at a standstill for many years. Actual growth is confined only to such saplings and older trees as are, from their size, capable of withstanding light fires. The direct effect of retarded reproduction would be much more apparent to consumers of timber in the region than it is now, if these forests were systematically cut over for the fullest utilization of timber. The present timber-producing stock would eventually be exhausted. Wooded areas which now give the impression to many of being constantly stocked and improving would soon be reduced to an unproductive state. Many acres of woodland are thus to be found which yield practically nothing, from the fact that all small stock is periodically destroyed.

Closely related to this retardation is the fact that constant destruction of humus reduces the productive power of the forest soil, both in point of richness and in the power of retaining moisture. A loss of the latter directly affects all agricultural lands below the wooded mountain slopes. For with all small vegetation and absorbing humus burned off, a large percentage of rain- and snow-water rushes over the clean surface to wash and erode the tilled lands below.

The common belief expressed by many people in this region, that the frequency of forest fires is beneficial in rendering each succeeding fire less and less dangerous is a pernicious fallacy, overlooking the damage just recited.



FIG. 1.—PITCH PINE, NEAR PINE PLAINS, EASTERN ALLEGANY COUNTY.

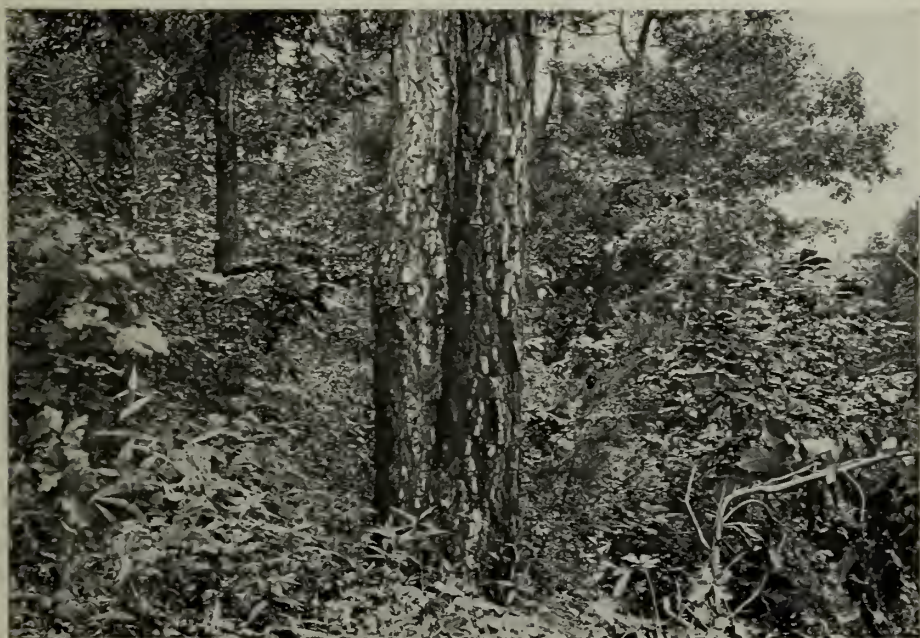


FIG. 2.—TABLE MOUNTAIN PINE, DANS MOUNTAIN.

FORESTS OF ALLEGANY COUNTY.

MANAGEMENT AND UTILIZATION OF FOREST RESOURCES.

Without a much more detailed examination than was possible in the brief time given the work by the writer, it would not be possible to formulate an adequate plan of management for the various forest types and conditions of this county. The needs of different sections of the county are not the same, and would, therefore, require special study. It is believed, however, that a statement of some of the general needs of Allegany county forests in point of treatment and utilization will not be out of place, and may even prove of considerable practical value to intelligent owners of woodlots. Indeed, it is gratifying to state in this connection that the farmers and other owners of woodlands, and officers in charge of forest lands in this region are remarkably well informed upon the condition and composition of their forests. The average intelligent farmer is perfectly familiar with the location and character of the principal timber trees of his region, and recognizes most of them even in their younger stages of growth. Such information is of great practical value, and with the suggestions to be given, will, for the time being, enable thoughtful men to improve their woodlots considerably.¹

Nearly sixty years of constant drain upon the forests of this county has reduced them to a state of the lowest productiveness, which has in turn led to an impression among many people that this resource is irretrievably gone. As already pointed out, however, the rapid natural reproduction in this region is most encouraging for a recuperation of these depleted forests if the latter can be placed under a conservative management. Moreover, it is believed that the large percentage of rocky hills and mountain land now in forest can be most profitably held in this condition; in fact, much of the hill and mountain land, once cleared and now abandoned, was evidently neglected because of low agricultural productiveness.

In conclusion, attention is called to the following general recom-

¹ For careful improvement and utilization of their forest lands owners are especially recommended to apply to the Division of Forestry, U. S. Department of Agriculture, for Circular 21, entitled "Practical Assistance to Farmers, Lumbermen and Others in Handling Forest Lands." (1898.)

mendations which are believed to be important in the management of woodlands in this county, both as looking to increased production of timber and to the protection of agricultural lands from erosion and the consequent deterioration. Discussions of these recommendations follow in detail:

1. Protection of forest lands from fire.
2. Exclusion of grazing from forest lands.
3. Regulation of indiscriminate cutting.
4. Regulation of indiscriminate clearing.

PROTECTION OF FOREST LANDS FROM FIRE.

Sufficient has been said as to the injury to forests by fires.

Fires in this region are commonly believed to be caused through the carelessness of pleasure parties, hunters, woodsmen and other people in the forests.

The penalty imposed by the Maryland law¹ for wilfully or carelessly setting forest fires appears to be adequate, but it is believed will never completely control the evil. The great difficulty under

¹ By an early statute in this state, it was forbidden to maliciously set on fire any woods, fences, marshes, lands, leaves, or rubbish thereon, within the counties of Baltimore, Anne Arundel, Frederick, Montgomery, Allegany, Queen Anne's, Harford, Cecil, or Prince George's, so as to occasion any loss, damage, or injury to other persons, under penalty of a fine not exceeding \$100, one-half to the informer and the other half to the county, besides the costs; or, if unable to pay this fine, by imprisonment not over six months. A slave thus convicted might be punished by whipping, not exceeding thirty-nine lashes, on the bare back, unless his owner chose to pay a fine not exceeding ten pounds. The owner of property injured or destroyed by such fires might recover its value from the party who caused it.

By an act passed March 29, 1838, entitled "An act to repair injuries done by fire from railroad engines," it was provided, that if any woods, fields, or other property, real or personal, be burned or injured by fire from engines, the company should pay the loss. Actions for damages under this act were to be tried at the first term of the court in which they are brought, if process be served on the defendant ten days before the court convenes, or, if not, then at the court next following. Service might be had upon any director, officer, attorney, agent, or servant of the defendant. Upon failure to appear, the court might, after the second term, upon proof of service by the sheriff's return, or by affidavit, enter a judgment by default against the defendant, by a jury impanelled at bar, as in cases of writs of inquiry.

the present status of securing conviction must always render this law an inadequate protection unless special provision be made to enforce it. This can be accomplished thoroughly only through the services of special officers.

Protection from forest fires in other states has been secured by the appointment of fire-wardens, whose duties are to enforce the fire law and exterminate forest fires. Chief fire-wardens are now regularly appointed by state authority in New York, Pennsylvania and Minnesota. In other states, where, as yet, these officers are not provided, local officers of the law (constables, etc.) have been made fire-wardens. The benefit of these systems of fire service in states, counties and townships possessing woodland is unquestionably great. As an example of this, it may be stated that the work of fire-wardens in the Preserve counties of northeastern New York has resulted in a recent very marked control and reduction in the number of forest fires. In addition to the special state fire-warden of New York, over two hundred supervisors in these counties are appointed deputy fire-wardens. The state provides that a compensation of two to two and one-half dollars a day be paid to deputy fire-wardens for actual time spent in fighting fires. In special cases of need these officers may hire a temporary force of men to assist in subduing fires; and for such service a per diem rate of two dollars is paid.

The establishment of a fire service for Western Maryland seems imperative. This section combines the most heavily wooded counties—Washington, Allegany and Garrett—and should, therefore, very fitly form the basis for establishing such protection. It is believed that the plan of combining the duties of fire-wardens with those of supervisors of these counties would be thoroughly feasible.

EXCLUSION OF GRAZING FROM FOREST LANDS.

The damage done to forest land by grazing is in the destruction of seedlings, by tramping and browsing, and in laying bare the surface, which is afterward dried out and washed. Under these conditions reproduction is either seriously checked or prevented.

A well-managed forest cannot serve for two purposes—good pas-

ture and the fullest production of timber. If woodland affords good grass pasture it is proof that the ground is not fully stocked with trees; and if trees are wanting in grassy places, most likely it is because the incoming seedlings have been trampled down from season to season by grazing cattle and so crowded out by the hardier grasses. A properly stocked forest managed for short rotations of small timber, such as mining props, ties, etc., should afford no forage for stock. Grazing should be relegated to cleared lands or to brush and woodlands intended only for grazing.

REGULATION OF INDISCRIMINATE CUTTING.

The injuries resulting from indiscriminate cutting are: removing needed seed trees of the most useful species, the leaving of old trees which are suppressing valuable young growth, and neglecting to lop waste tops and trunks which otherwise fail to rot and supply fuel for fire.

Timber-cutting in the past has not left a sufficient number of seed trees of the valuable species. The loss of a proper number of seed trees is a disadvantage to the forest in depriving it of immediate means of reproducing the kinds thus taken out. The return of species from distant sources is slow and involves a loss of valuable time. Care should be taken, therefore, in marking trees to be cut out, that three to four seed trees of all the original useful timber species of a locality be left evenly distributed on every acre.

The timely removal of old trees which are suppressing and damaging young timber is urgent. The need of such discriminative cutting is very apparent in the forests of this county. As an example of this need may be mentioned the suppression caused by a single large White Oak standing on the lower east slope of Warrior Mountain. Eight large sapling White Pines, four White Oaks, two Hickories, two Walnuts, and one Shortleaf Pine were all entirely overtopped by the heavy crown of the old White Oak, and were becoming stunted and twisted in their efforts to reach the needed light. The removal of the White Oak would have allowed these saplings to advance. Failure to relieve them at the proper time has already pre-



FIG. 1.—SHORTLEAF PINE AND HARDWOOD, NEAR PINEY GROVE.



FIG. 2.—CUT-OVER HARDWOOD FOREST, SAVAGE MOUNTAIN.

vented five to six years of profitable growth. Suppression of this kind is easily recognized and remedied by any intelligent farmer or woodsman.

In the majority of cases where timber is cut for sawlogs, ties and props, from 10 to 30 per cent or more of the trees is left on the ground as waste tops; and in the case of timber cut for tan-bark, the entire trunks are commonly left unused. The danger of neglecting unlopped, waste treetops, especially of hardwoods, is that the timber is usually braced up from the ground where it seasons thoroughly and rots very slowly, affording additional fuel for forest fires. The burning of this material was observed to have done severe damage to large trees standing near or in contact with it.

Strict economy would not allow hardwood tops to be wasted when they can be cut into fuel. But if circumstances are such as to make this entirely impracticable or unprofitable, the refuse should be cut and disposed on the ground so that it will decay as rapidly as possible. The essential point is to bring it all in contact with the ground, where it will decay. To accomplish this properly it will be necessary to lop all large limbs which stand above ground.

Precaution should be used in felling large timber so as not to drop a big top, which must be left unused, near or in contact with large standing trees. Such refuse tops should be placed, in felling, in open places distant as far as possible from standing timber in order to avoid burning the latter in case of fire. The labor of properly reducing waste hardwood tops will often be considerable, while the lopping of the much smaller branches of unused conifer tops can be done more quickly.

Most farmers can easily carry out these precautions when doing the cutting themselves or superintending it. It will be difficult, however, to enforce this extra work in contract cutting, except under the most rigid insistence. In the case of timber stolen, which not infrequently occurs in the mountain forests, attention to waste tops will of course be entirely neglected.

REGULATION OF INDISCRIMINATE CLEARING.

Examples of injudicious clearing are to be seen in many sections of this county, and include the instances where narrow hill-tops, mountain ridges and steep slopes have been stripped of their forest cover. Heavy surface washing and deep trenching follow these clearings not only on the high slopes thus cleared, but also on the better lands lower down. The result is a constant impoverishment of the soil. The rapid deterioration of these naturally thin hill soils under constant surface washing is abundantly attested in the fact that many acres are now abandoned. Reference has been made also to the increased rise of water in streams during the spring and fall as a result of indiscriminate clearing.

THE FAUNA AND FLORA

THE LIFE ZONES AND AREAS OF ALLEGANY COUNTY

BY

C. HART MERRIAM

The best guide to the agricultural capabilities of a region is afforded by the distribution of the native animals and plants; for experience has shown that areas characterized in a state of nature by the presence of particular species are adapted to the cultivation of particular varieties of agricultural crops. The importance of this fact is so great that the national government has been engaged for years in a biological survey of the United States with a view to determining the boundaries of the areas inhabited by different associations of animals and plants.

It has been found that North America may be divided primarily into two vast regions: a northern or Boreal, and a southern or Austral, according to the sources from which the native animals and plants were derived. The boundary between these areas lies, in the main, north of the United States, but disconnected arms or tongues of the Boreal area push far southward into the United States along the summits of the higher mountain ranges—the Alleghanies in the east and the Rocky Mountains and Sierra-Cascade system in the far west.

The state of Maryland, owing to its southern position, is in the southern or Austral region, but the high mountains in the western part of the state are so much colder than the lower lands on the east that their summits are in places inhabited by species characteristic of the northern or Boreal region. Excepting these small mountain summits, the total area of which is insignificant, Maryland lies wholly

within the Austral region. This region is commonly divided into several belts, known to naturalists as Lower Austral, Upper Austral, and Transition. The Transition, as its name implies, is a belt of overlapping of northern and southern types. The Lower Austral, or Austroriparian, belt begins on the east coast at the mouth of Chesapeake Bay and takes a southerly and westerly course around the southern end of the Alleghanies. The Upper Austral, or Carolinian, belt extends from the neighborhood of New York City southerly along the coast to Chesapeake Bay and includes the whole state of Maryland except the mountains. The mountains fall mainly within the Alleghanian division of the Transition zone, and, as already remarked, a few of their higher summits are strongly tinged with Boreal forms.

While the Boreal region has too cold a climate for successful agriculture, all of the Austral zones are of agricultural importance. The whole of the state of Maryland, therefore, so far as its climatic conditions and life zones are concerned, is an agricultural state—no part being too cold for the cultivation of crops. The rainfall and humidity also are neither too scanty nor too excessive for agriculture: hence, except where unfavorable topographic and soil conditions prevent, the whole state may be made productive.

A very hasty examination of Allegany and Garrett counties recently made by my assistants, Vernon Bailey and E. A. Preble, at the request of Professor William Bullock Clark, Director of the Maryland Geological Survey, shows that Garrett county and the western part of Allegany county (west of Piney Mountain and the Potomac valley) are mainly in the Alleghanian area of the Transition zone, and that the eastern part of Allegany county (east of Cumberland) is mainly in the Carolinian area of the Upper Austral zone.

Tongues of the Carolinian fauna, characterized by the tulip tree, sycamore, red bud, sassafras, sweet gum, dogwood, and scrub pine,¹ occupy the narrow valleys of the North Branch of the Potomac river, Wills Creek, Jennings Run and Braddock Run, and reach up,

¹ Among the characteristic animals of the Carolinian area of Maryland are the opossum, fox squirrel, cardinal bird, Carolina wren, tufted titmouse, gnatcatcher, Carolina chickadee and summer tanager.

as a rule, to an altitude of 1200 or 1300 feet. Above this, the whole county, except the warmest slopes, which are tinged with Carolinian forms, belongs to the Transition zone. In Garrett county, in the upper part of the Transition zone (above 2600 feet altitude) cold sphagnum and alder swamps abound. These swamps contain a strong admixture of high Transition and even Boreal species, such as the Junco, or Slate-colored Snowbird (*Junco hyemalis*), Solitary Vireo (*Vireo solitarius*), Magnolia Warbler (*Dendroica maculosa*), Canadian Warbler (*Wilsonia canadensis*), Redbreasted Nuthatch (*Sitta canadensis*), Hermit Thrush (*Hylocichla aonalaschkae pallasii*), Redbacked Mouse (*Evotomys gapperi*), Canadian White-footed Mouse (*Peromyscus canadensis*), two species of Jumping Mouse, or Jerboa (*Zapus hudsonius* and *Z. insignis*), Varying Hare (*Lepus americanus virginianus*), and the northern Sooty Shrew (*Sorex fumeus*), all of which were obtained by E. A. Preble at Finzel post-office, six miles north of Frostburg. Still farther west the Boreal tinge is even stronger, and in some very extensive swamps between Accident and Bittinger (mainly on the west side of the wagon road) Mr. Preble found spruce trees common. The cutting off of the spruce and hemlock from these small boreal islands lets in the hot sun and results, in numerous instances, in changing the fauna and flora from Canadian to Alleghanian.

The fauna of Allegany county is a mixture of Carolinian and Alleghanian species and comprises, so far as known, no boreal islands. The Potomac valley, and valleys of the principal streams, are Carolinian; the uplands, Alleghanian.

THE SUMMER BIRDS OF WESTERN MARYLAND

BY

EDWARD A. PREBLE

During the summer of 1899 three short trips were made to western Maryland for the purpose of studying its fauna and flora in the joint interests of the U. S. Department of Agriculture and the Maryland Geological Survey. The time spent in the field aggregated about a month. Special attention was paid to birds and mammals—the plants, for lack of time, being merely noted incidentally with reference to their bearing on the different life areas of the region.

A short preliminary trip was made in May. Reaching Frostburg, near the western border of Allegany county, eleven miles west of Cumberland, a suitable place for a few days' work was found in Finzel, a postoffice near the northeast corner of Garrett county, about a mile and a half west of the main ridge of Great Savage Mountain, at this point having an altitude of nearly 3000 feet. Finzel lies some 400 feet lower. About midway in distance and altitude between Finzel and Great Savage lies Little Savage Mountain. These ridges are covered with a rather sparse growth of oaks and chestnuts. In the shallow depression between them is a dense swamp, the main source of Savage river. This swamp is densely grown up to hemlock (*Tsuga canadensis*), black spruce (*Picea mariana*), tamarack (*Larix laricina*) and several other species, with a dense undergrowth composed mainly of *Rhododendron maximum*. To the west of Finzel the country is cut up by numerous ridges mainly covered with oak and chestnut, the intervening valleys being rather swampy and traversed by small brooks, and usually clothed with heavy forest, hemlock and rhododendron predominating and often extending nearly to the summit of the ridges on their western slopes.

After spending several days about Finzel, mainly engaged in trapping mammals; having obtained a fair knowledge of the mammalian fauna, it seemed desirable to ascertain the conditions in other portions of the county. The turnpike road was traversed westward from Frostburg across Great Savage, Meadow and Negro mountains to Keyser Ridge, and thence, leaving the turnpike, the country was examined southward to Accident, across Negro Mountain to Bittinger, thence by a circuitous route to Grantsville, and back to Frostburg. Several large tracts of coniferous woods were located and gave promise of interesting results if visited later in the season.

Beginning June 17th, 5 days were spent in studying and collecting the birds about Finzel, among which were several species not before recorded as breeding within the state. On June 22, the point of study was shifted westward to Grantsville in Garrett county, a small town situated on a ridge overlooking the valley of the Castleman, about two miles south of the Pennsylvania line, and a point of departure was located at a farmhouse about two miles east of town from which the valley of the Castleman and the ridges to the eastward could be easily worked. Most of the country is covered with a rather heavy growth of deciduous trees, oaks and chestnuts predominating. A good-sized tract of hemlock stands near the turnpike three miles east of Grantsville and a considerable quantity also remains on the western slopes of the ridges near the Castleman, where red-berried elder and rhododendron abound. At this point the valley of the Castleman lies at an altitude of about 2100 feet, while the ridges in the vicinity rise four or five hundred feet higher.

White pine was formerly found in this region in great abundance, but has now almost entirely disappeared. The axe of the lumberman has latterly been directed to the hemlock and spruce, which in turn are fast disappearing.

On June 27 the field of observation was transferred to Bittinger, a postoffice about nine miles south of Grantsville on the plateau between the north and south branches of the Castleman. Its altitude is about 2600 feet. Considerable tracts of hemlock and spruce occur in the vicinity, and in their shade were found *Taxus minor*, *Dirca*

palustris, *Oxalis acetosella* and other northern plants, and also many interesting birds to be mentioned later.

On July 1 another change was made to Mountain Lake Park in the southern part of Garrett county. Here, as throughout the county, the face of the country is traversed by numerous chestnut ridges having a general northeast and southwest trend, but coniferous forests are entirely absent. In the vicinity of Kearney, some hemlock woods still remain and there are several species of birds not observed at Mountain Lake Park. A considerable quantity of hemlock occurs on the western slopes of Great Savage Mountain in the vicinity, with an undergrowth of *Rhododendron maximum*, *Taxus minor*, and *Oxalis acetosella*.

Study and collecting trips were also made to Rawlings, Dans Mountain, Oldtown, and Little Orleans, where short stops were made to ascertain what birds were common in the vicinity.

Following is a list of the birds observed during the several trips. They were all seen between June 17 and July 24 (with the exception of *Otocoris*), and while of course the nests of all the species were not found, there is no doubt that all were breeding in the vicinity. A male horned lark in full song, observed near Accident on May 18, was doubtless breeding. Several olivebacked thrushes were seen near the borders of the tamarack swamp near Finzel on May 15 and may breed there, but since they may have been migrants, and since they were not found there in June, the species is not included in the following list. The wild turkey occurs throughout the wilder parts of the region but was not observed. The number of species recorded would doubtless have been considerably increased had it been possible to devote the time entirely to birds.

LIST OF SUMMER BIRDS IN WESTERN MARYLAND.

Ardea virescens. GREEN HERON.—Though doubtless occurring elsewhere in the region, Green Herons were observed only along the Potomac and its tributaries. One was seen near Rawlings and a number of adults and young were observed at Little Orleans and Old-

town. At the latter place two broods of young, which had left the nests and were climbing about among the branches, were seen.

Philohela minor. WOODCOCK.—The tracks and borings of a Woodcock were seen at the edge of a swamp at Finzel, and several were seen at Grantsville and Mountain Lake Park.

Actitis macularia. SPOTTED SANDPIPER.—Several were noticed on the shores of the Castleman, near Grantsville, and also a number along the Potomac at Oldtown and Little Orleans.

Aegialitis vocifera. KILLDEER PLOVER.—A pair of Killdeer Plovers were seen in a field near Rawlings on July 21.

Colinus virginianus. QUAIL.—This species seemed to be fairly common throughout the region. It was heard several times near Grantsville, where they are said to be abundant some seasons. Several were heard between Grantsville and Bittinger, and the species was also noted at Mountain Lake Park, Rawlings, Oldtown, and Little Orleans.

Bonasa umbellus. RUFFED GROUSE.—This species was abundant in the higher parts of the region. Three females each, with a brood of young, were observed near Finzel and the birds seemed equally abundant near Grantsville, and were also observed at Bittinger and on Dans Mountain, near Rawlings.

Zenaidura macroura. MOURNING DOVE.—The Mourning Dove was noted in small numbers at Bittinger, Mountain Lake Park and Swanton. It was abundant near Rawlings and Oldtown.

Cathartes aura. TURKEY BUZZARD.—This species was seen in small numbers at Bittinger, Swanton, Dans Mountain, Oldtown and Little Orleans.

Accipiter velox. SHARP-SHINNED HAWK.—A pair seen at Mountain Lake Park, and one in deep woods near Swanton. Its actions seemed to indicate that it had a nest in the vicinity.

Accipiter cooperi. COOPER'S HAWK.—One was seen perched in a dead tree on a partially cleared hillside near Swanton. I decoyed it quite near by imitating the cry of a bird in distress.

Buteo borealis. RED-TAILED HAWK.—Only seen once, a few miles north of Rawlings. The bird was sailing about over the valley.

Buteo lineatus. RED-SHOULDERED HAWK.—A very noisy pair seen daily at Finzel, and the species was also noted near Grantsville. A nest in a large birch in deep woods near Bitteringer had probably been occupied by a pair of these birds, which were several times observed in the vicinity.

Buteo latissimus. BROAD-WINGED HAWK.—One was taken on the summit of the ridge about three miles east of Grantsville.

Falco sparverius. SPARROW HAWK.—This species was noted at Grantsville, Bitteringer and near Mountain Lake Park, only one being seen at each place.

Megascops asio. SCREECH OWL.—The familiar notes of this species were heard several times during the night of June 24, at Grantsville. Though doubtless found throughout the region, the bird was not elsewhere noted.

Bubo virginianus. GREAT HORNED OWL.—The remains of a brood of full-grown young were seen in the woods near Finzel. I saw one near Bitteringer, one evening about dusk, perched on a high dead tree, at the edge of the forest. It soon started off in search of food.

Coccyzus americanus. YELLOW-BILLED CUCKOO.—Several were seen and heard at Finzel and one was taken on June 20.

Coccyzus erythrophthalmus. BLACK-BILLED CUCKOO.—One was taken near Grantsville on June 26.

Ceryle alcyon. KINGFISHER.—One was seen near Oldtown on July 23.

Dryobates villosus. HAIRY WOODPECKER.—Fairly common over the higher portions of the region. One was taken at Finzel and several seen in oak and chestnut woods near Grantsville. A pair, accompanied by young, were seen in deep woods near Bitteringer.

Dryobates pubescens. DOWNY WOODPECKER.—Evidently not common. The species was noted at Grantsville, Bitteringer, and near Rawlings, only a single individual being noted in each case.

Sphyrapicus varius. YELLOW-BELLIED WOODPECKER.—Rather common and generally distributed over the higher portions of the region. A few were noted near Finzel. A pair seen near Grantsville June 23 evidently had a nest near by. Old birds, accompanied

by young not long from the nest, were seen at Bittinger and Mountain Lake Park, and later both old and young birds were observed at Swanton.

Ceophloeus pileatus abieticola. NORTHERN PILEATED WOODPECKER.—A bird of this species was seen in heavy mixed woods near Swanton. It doubtless occurs sparingly throughout the region, as it was heard in several places.

Melanerpes erythrocephalus. RED-HEADED WOODPECKER.—Quite generally distributed and common throughout the greater part of Garrett county traversed. It was fairly common about Grantsville and abundant at Bittinger and Mountain Lake Park. The birds seemed to delight in the tall dead oaks and chestnuts left in the clearings. They paid frequent visits to the cultivated cherry trees which are common throughout the region.

Colaptes auratus luteus. NORTHERN FLICKER.—Very common and generally distributed throughout the region.

Antrostomus vociferus. WHIPPOORWILL.—Whippoorwills were heard nightly at Finzel and near Grantsville. I also heard several at Swanton during the night of July 18, but did not note the species elsewhere.

Chordeiles virginianus. NIGHTHAWK.—A few were seen at Bittinger, Mountain Lake Park, Swanton, Rawlings and Oldtown.

Chaetura pelagica. CHIMNEY SWIFT.—This species was very generally distributed throughout the region and was everywhere common, and in the vicinity of the towns, abundant.

Trochilus colubris. RUBY-THROATED HUMMINGBIRD.—The ruby-throat seemed to be uncommon. Only one was seen at Bittinger and one near Rawlings. A number were noted at Swanton and along the roadsides near Oldtown.

Tyrannus tyrannus. KINGBIRD.—Rather common and generally distributed throughout the region, being noted at all the places visited.

Myiarchus crinitus. CRESTED FLYCATCHER.—Rather common near Grantsville, Mountain Lake Park, Swanton and about Rawlings and Dans Mountain.

Sayornis phoebe. PHOEBE.—Generally distributed but rather rare. With the exception of Mountain Lake Park, it was seen in small numbers at all the localities visited.

Contopus virens. WOOD PEWEE.—Fairly common and very generally distributed, being noted as more or less common at all the localities visited.

Empidonax virescens. ACADIAN FLYCATCHER.—This species was seen on only one occasion, at Oldtown.

Empidonax traillii alnorum. ALDER FLYCATCHER.—A number were seen in alder thickets in the meadows and springy places near Mountain Lake Park, and two males were taken July 3 and 4. They were rather active and frequently uttered their characteristic note, but were shy and generally kept concealed on the opposite side of a thicket of alders, and the specimens taken were secured with some difficulty.

Empidonax minimus. LEAST FLYCATCHER.—One was seen and taken in an apple orchard near Grantsville.

Otocoris alpestris praticola. PRAIRIE HORNED LARK.—While driving through Garrett county on May 18, I saw a male bird of this species. He was on a rail fence singing lustily and was not at all shy. It was near the town of Accident, about ten miles from the northwest corner of the county. There can be little doubt that the bird was breeding.

Cyanocitta cristata. BLUE JAY.—This bird was noted as common at all the places visited except Oldtown and Little Orleans. Young, not long from the nest, being fed by their parents, were observed at Bittinger on June 28. They had notes very similar to those of young crows.

Corvus corax principalis. NORTHERN RAVEN.—A pair of ravens were seen on several occasions at Finzel. They were said to have a nest in a large hemlock near that place which they had occupied for several successive seasons.

Corvus americanus. COMMON CROW.—Fairly common and generally distributed, being noted at all the localities visited. Young birds not long from the nest were seen at Grantsville and Bittinger late in June.

Dalichonyx oryzivorus. BOBOLINK.—A pair of Bobolinks were observed in a field near Grantsville on June 23. The bird is said to be a regular summer visitor, but is not common. No others were seen.

Molothrus ater. COWBIRD.—A small flock of Cowbirds was seen in a field near Rawlings on July 22.

Agelaius phoeniceus. REDWINGED BLACKBIRD.—Quite common in the meadows and low fields in the valley of the Castleman near Grantsville. A few were also seen at Mountain Lake Park, Bittinger and Oldtown.

Sturnella magna. MEADOW LARK.—Common and quite generally distributed throughout the region. Numbers were seen at Grantsville, Bittinger, Mountain Lake Park, Rawlings and Oldtown.

Icterus galbula. BALTIMORE ORIOLE.—During my stay near Grantsville I saw several in a cherry tree near the house. At Mountain Lake Park, I took one, which was feeding on the berries of the "Service Tree" (*Amelanchier*). Several individuals, evidently a family, were seen in the oak woods near the base of Dans Mountain, near Rawlings.

Quiscalus quiscula. PURPLE GRACKLE.—Several bands, consisting of old birds accompanied by young not long from the nest, were seen at Bittinger. They seemed interested mainly in the cherry trees, which at the time were loaded with ripening fruit. They were very noisy, and except when feeding, were quite shy. Specimens taken were intermediate between *quiscula* and *aeneus*, as might be expected. The species was also noted at Mountain Lake Park and Swanton.

Astragalmus tristis. AMERICAN GOLDFINCH.—This species was common and very generally distributed throughout the region, being seen almost daily at all the places visited.

Pooecetes gramineus. VESPER SPARROW.—This species was abundant in the fields about Finzel, Grantsville and Bittinger and was also noted at Rawlings.

Ammodramus savannarum passermus. GRASSHOPPER SPARROW.—A number of these birds were seen along roadsides in the vicinity of Rawlings.

Spizella socialis. CHIPPING SPARROW.—This familiar species was common and very generally distributed throughout the region. A nest containing four fresh eggs was found at Finzel on June 21.

Spizella pusilla. FIELD SPARROW.—This species was noted in considerable numbers at all the places visited, excepting Oldtown and Little Orleans.

Junco hyemalis carolinensis. CAROLINA JUNCO.—Fairly common about the open portions of the hemlock woods in the vicinity of Finzel. It was also seen in the vicinity of a hemlock forest about 3 miles east of Grantsville on June 22. During my stay at Bittinger the species was observed daily and young, apparently just from the nest, were seen June 29.

During a drive through Garrett county, on May 18, I found a nest of this species near Bittinger, containing four apparently fresh eggs. The site was beneath the edge of a mossy bank within a few feet of the highway.

Melospiza fasciata. SONG SPARROW.—This bird was noted as common at all the places visited.

Pipilo erythrophthalmus. TOWHEE.—Noted in considerable numbers in scrubby oak woods in the vicinity of Finzel, Grantsville, Mountain Lake Park, Swanton, and on Dans Mountain, near Rawlings.

Cardinalis cardinalis. CARDINAL.—This species was rather common in the valley of the Potomac near Rawlings, Oldtown and Little Orleans. In the higher portions of the region it was observed but once, in the valley of the Castleman about three miles northeast of Grantsville.

Zamelodia ludoviciana. ROSEBREASTED GROSBEEK.—Rather common in mixed and deciduous woods about Finzel. I saw a pair in mixed woods near Bittinger, and one near Swanton.

Cyanospiza cyanea. INDIGO BUNTING.—Common and very generally distributed throughout the region, being noted at all the places visited excepting Bittinger and Swanton, where it was probably overlooked. A nest found near Grantsville on June 23 contained young just hatched.

Piranga erythromelas. SCARLET TANAGER.—Fairly abundant at all the places visited excepting Oldtown and Little Orleans.

Progne subis. PURPLE MARTIN.—Several colonies were observed about Mountain Lake Park, and a colony at Frostburg in the north-western part of Allegany county.

Petrochelidon lunifrons. CLIFF SWALLOW.—This familiar species noted in the vicinity of nearly every farmhouse throughout the higher part of Garrett county. It was common near Finzel, Grantsville, Bittinger and Mountain Lake Park. Great numbers of their nests were seen beneath the overhanging portions of the old-fashioned barns.

Hirundo erythrogaster. BARN SWALLOW.—Generally distributed and common throughout the region, being noted, usually in large numbers, at every place visited, excepting Oldtown. They nested in nearly every barn through the country. In the vicinity of Grantsville, June 22-27, great numbers of young birds just from the nest were observed.

Clivicola riparia. BANK SWALLOW.—A single bird was seen at Little Orleans on July 24.

Ampelis cedrorum. CEDAR WAXWING.—Noted in abundance at Finzel, Grantsville, Bittinger, Mountain Lake Park and Swanton. A nest found at the latter place on July 19 contained three eggs. A few individuals were also seen at Oldtown.

Vireo olivaceus. RED-EYED VIREO.—This species was very abundant and generally distributed throughout the region, being observed at all the places visited.

Vireo flavifrons. YELLOW-THROATED VIREO.—A number were observed in thickets bordering the Potomac at Oldtown.

Vireo solitarius. SOLITARY VIREO.—This species was fairly common in hemlock and mixed woods near Finzel, Grantsville and Bittinger. I took a specimen near Kearney, a few miles southeast of Mountain Lake Park, and the song of one was heard at Swanton. I also saw several on Dans Mountain. Specimens taken at Finzel and near Kearney show some slight approach in measurements and color of upper parts to *V. s. alticola*, but, on the whole, seem much nearer to the typical form.

Minotilta varia. BLACK AND WHITE WARBLER.—Common and quite generally distributed. It was seen at all the places visited ex-

cepting Grantsville and Little Orleans, where it was probably present, but overlooked. About the base of Dans Mountain, near Rawlings, a number were seen searching for food on the rail fences, often at a considerable distance from the roads.

Helmitherus vermivorus. WORM-EATING WARBLER.—One was taken about half-way up Dans Mountain, near Rawlings, on July 21, and a day or two later I saw one at Oldtown.

Helminthophila chrysoptera. GOLDEN-WINGED WARBLER.—A number were seen and one taken in young growth near Swanton, and I saw several on Dans Mountain near Rawlings.

Composthlypis americana. PARULA WARBLER.—One was seen at Oldtown on July 23, and another the day following at Little Orleans.

Dendroica aestiva. YELLOW WARBLER.—A pair observed near Grantsville late in June, and several at Oldtown and Little Orleans, were the only ones noted during my trip.

Dendroica caerulescens. BLACK-THROATED BLUE WARBLER.—Rather common at Finzel and Bittinger, where deserted nests were noticed and at Swanton. I also took an individual near Kearney, a few miles southeast of Mountain Lake Park. Several specimens taken exhibit considerable black on the back, supposed to be indicative of subspecies *cairn sii*, but which seems more likely to be an indication of high plumage increasing in intensity as the bird grows older.

Dendroica maculosa. MAGNOLIA WARBLER.—Common in the hemlock and spruce forests throughout the higher portions of Garrett county. It was noted in considerable numbers at Finzel, Bittinger and Swanton, and several seen in a grove of hemlocks near Kearney several miles southeast of Mountain Lake Park. A nest found near Bittinger on June 27 contained three fresh eggs; another was deposited the next day. The nest was situated in a small hemlock about four feet from the ground, a characteristic situation. The late date would seem to indicate a second litter, though I saw no young birds.

Dendroica pennsylvanica. CHESTNUT-SIDED WARBLER.—A common bird over most of the higher portions of Garrett county. Many were observed at Finzel, and a newly-built nest was seen. It was also common at Grantsville and Mountain Lake Park, and young birds were taken on Dans Mountain, near Rawlings, on July 21.

Dendroica blackburniae. BLACKBURNIAN WARBLER.—Rather common in the hemlocks about Finzel. I saw one near Bittinger on June 30 and took one on Dans Mountain, near Rawlings, on July 21.

Dendroica virens. BLACK-THROATED GREEN WARBLER.—A female was seen at Finzel on June 18.

Dendroica discolor. PRAIRIE WARBLER.—Several were seen in bushy woods at Oldtown July 22-23.

Seiurus aurocapillus. OVEN-BIRD.—A very common species throughout the region.

Seiurus noveboracensis. WATER-THRUSH.—This species was fairly common about Finzel, especially in a swamp between Big and Little Savage Mountains. Nearly every small stream flowing through low woods had a pair or two. A single bird was observed at Swanton.

Seiurus motacilla. LOUISIANA WATER-THRUSH.—Though normally affecting low altitudes, this species frequently follows small streams up to their source. One was thus observed near Finzel along a brook flowing through a dense hemlock forest, whose undergrowth of Rhododendron and Kalnia also afforded a congenial shelter to *S. noveboracensis*. Several were seen along Crabtree Run, near Swanton, and I took a specimen on Dans Mountain July 21.

Geothlypis trichas. MARYLAND YELLOW-THROAT.—Noted in rather small numbers at Finzel, Grantsville, Mountain Lake Park, Rawlings, Oldtown and Little Orleans.

Icteria virens. YELLOW-BREASTED CHAT.—A pair or two noted in the vicinity of Finzel. It was rather common about Mountain Lake Park, Swanton, Rawlings, Oldtown, and Little Orleans.

Wilsonia mitrata. WILSON'S WARBLER.—In thickets of young growth on the lower slopes of Dans Mountain, near Rawlings, this species was rather common.

Wilsonia canadensis. CANADIAN WARBLER.—This was the most abundant warbler at Finzel, where old birds were seen feeding young just from the nest about June 20. The species was rather common in the rhododendrons, which abounded in favorable situations in the valley of the Castleman near Grantsville. It was also rather common about Swanton.

Setophaga ruticilla. AMERICAN REDSTART.—A pair observed at Finzel, and a number seen at Swanton, Rawlings, Oldtown and Little Orleans.

Galeoscoptes carolinensis. CATBIRD.—A very abundant breeder throughout the region.

Harporhynchus rufus. BROWN THRASHER.—A few were seen near Finzel, Grantsville and Bittinger.

Thryothorus ludovicianus. CAROLINA WREN.—One was noted in a garden near Oldtown.

Thryomanes bewickii. BEWICKS WREN.—I saw one by the roadside near Bittinger on June 30, and found both old and young birds rather common on Dans Mountain, near Rawlings, on July 21.

Troglodytes aedon. HOUSE WREN.—A male in full song was seen several times about Little Orleans on July 24.

Certhia familiaris fusca. BROWN CREEPER.—A female was taken in heavy hemlock woods near Bittinger on June 28.

Sitta carolinensis. WHITE-BREASTED NUTHATCH.—Very common and generally distributed throughout the region.

Sitta canadensis. RED-BREASTED NUTHATCH.—A small flock of these birds, evidently a family, was seen on the branches of a tall dead tree, in the deep woods near Bittinger. It was also seen near Finzel about the middle of May, when it was doubtless breeding.

Parus bicolor. TUFTED TITMOUSE.—A number were seen in thickets beside the Potomac near Oldtown on July 23.

Parus atricapillus. BLACK-CAPPED TITMOUSE.—Rather common about Finzel, Bittinger and Mountain Lake Park.

Hylocichla mustelinus. WOOD THRUSH.—A very common bird about Finzel, Grantsville, Bittinger and Mountain Lake Park. Its song was also heard on Warrior Mountain about 4 miles north of Oldtown.

Hylocichla fuscescens. WILSON'S THRUSH.—Generally distributed over the higher portions of Garrett county, being common about Finzel, Grantsville, Bittinger, Mountain Lake Park and Swanton. A few were also seen on Dans Mountain, near Rawlings.

Hylocichla aonalaschkae pallasii. HERMIT THRUSH.—Several of

these birds were heard in the "oak barrens" near Finzel. Its song was also heard once near Grantsville and once at Bittinger. In the white oak woods near Mountain Lake Park, several were heard and two taken.

Merula migratoria. ROBIN.—A very common breeder throughout the region.

Sialia sialis. BLUEBIRD.—Common and generally distributed throughout the region. A brood of young, accompanied by their parents, was seen near Finzel on June 17.

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